DEVELOPMENT, CONSTRUCTION & TESTING

OF A PROTOTYPE ELECTRO-HYDRAULIC

MINI SCALER (UP-T-155-1)

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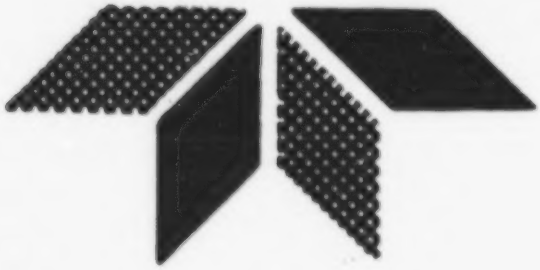

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August 13, 1985.

CANMET,
Dept. of Energy, Mines & Resources,
555 Booth Street,
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Attention: Dr. J. Pathak.

Subject: FINAL REPORT.

Project Title: Development, Construction & Testing of a Prototype Electro-Hydraulic Mini-Scaler (UP-T-155-1).

Canmet Project No.: 2-9173.

Gentlemen:

Please find enclosed the original plus ten (10) bound copies with four (4) microfiche copies of the Final Report for the above project. The final report includes all the necessary changes requested by you.

We thank you for sponsoring this complex and very useful project and look forward to similar future associations.

Yours very truly,

TELEDYNE CANADA
MINING PRODUCTS

B. Pal, P. Eng.,
President.

BP/bd
Encls.

T I T L E : DEVELOPMENT, CONSTRUCTION & TESTING OF A PROTOTYPE ELECTRO-HYDRAULIC MINI SCALER (UP-T-155-1)

FINAL REPORT BY TELEDYNE CANADA MINING PRODUCTS

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ABSTRACT

The process of rock scaling by manual methods is hazardous and inefficient in underground mines and tunnels.

Mechanized scaling in conjunction with remotely locating the operator, is potentially a method of improving the safety and efficiency of the scaling operation. While mechanized scaling is available for large operations, these large units are unsuitable for use in 80% of Canadian mining operations. Thus, the development of a compact scaling unit with a large working reach would open these mining operations to mechanized scaling.

Under contract with Supply and Services Canada and Energy, Mines & Resources, Teledyne Canada Mining Products was commissioned to design, construct and test a "Hydraulic Mini Scaler". The unit, developed over a two year period, was tested at three field locations with encouraging results. It has demonstrated the ability to perform mechanized scaling and demolition work productively while vastly improving the safety zone of the operator.

INTRODUCTION

Scaling is the procedure of removing loose slabs of rock from roofs and walls of tunnels or openings in underground mines. This is done after blasting operations, and at present, is accomplished by a manual method using scaling bars to pry the loose from the surface. These manually manipulated bars represent a slow, unsafe method, and the procedure creates a major bottleneck in otherwise modern, mechanized systems utilized in underground tunnelling and mining. While mechanized scaling is available for large operations, the equipment is large and heavy. This type of unit is unsuitable for 80% of mining operations, which may be categorized as small or medium sized.

A small, compact unit with a large working reach referred to as a "Electro-Hydraulic Mini Scaler" was proposed as a solution to improve the efficiency and safety of the scaling operation in small and medium sized headings. This unit was to permit work in headings as small as 8 ft. x 8 ft. and provide a reach up to 20 ft. for use in large headings and stopes. The versatility of the boom would also permit the unit to perform "light" breaking duties of oversize as a secondary operation. This unit was tangentially aimed at performing tasks in the construction (demolition) industry as well as the metallurgical field (refractory linings). This would entail demolition work of bridges, buildings, roadwork, etc. where larger and heavier units would prove unsatisfactory.

In the metallurgical field, usage would include break up and removal of furnace refractory linings, ladle cleanout, slag track cleanout, etc.

Under Unsolicited Proposals Programme of Supply & Services Canada, Teledyne Canada Mining Products was commissioned to design, construct, test and evaluate a "Hydraulic Mini Scaler", File Number UP-T-155-1 on January 20, 1983.*

This report deals in detail with the total development of the "Hydraulic Mini Scaler" from initial design concepts through to on-site testing.

* This project was sponsored and monitored by Canada Centre for Minerals & Energy Technology, Energy, Mines & Resources.

WORK UNDERTAKEN/TECHNICAL DISCUSSION

1. PRELIMINARY DESIGN CRITERIA

Preliminary design criteria was written to provide a framework in which to begin making initial design decisions associated with the market targets.

Design criteria as follows:

A) Will permit work in headings a minimum of 8 feet x 8 feet.

B) Will permit work in headings and stopes up to 20 feet high.

C) Will be capable of operating in a rock breaking mode.

D) May be tangentially used in the construction and metallurgical industries.

E) Will, through a remote operating station, increase the safety of operations.

F) Will increase productivity over present manual methods.

G) Will be electro-hydraulically powered to reduce operating costs and emission problems over diesel powered package.

H) Will be hydrostatic four wheel drive.

I) Will be rubber tired, and skid steered for maneuverability.

J) Will share common hydraulic components for boom and tram functions.

K) Will have parallel movement of boom.

L) Will have infinitely variable boom of up to 20 foot reach while capable of collapsing to a compact size for tramming/transport.

M) Will have individually controlled hydraulic stabilizers.

N) Will have a slewing movement of boom preferably of 360°.

O) Will be capable of accepting hydraulic breakers up to 1500 lbs. (680 kg) weight and up to 1000 ft. lbs. (1300 Joules) blow energy.

P) Will be remotely controlled, with full proportionality of all functions from a portable control panel.

Q) Will be capable of climbing a continuous grade of 25% and holding when stopped.

R) Will have hydro-dynamic braking only.

Based on the above criteria the attached preliminary specifications were formulated.

2. PRELIMINARY SPECIFICATIONS

ELECTRO-HYDRAULIC MINI SCALER

PRIME MOVER

30 h.p. (22.4 kW) electric motor
575 V, 60 Hz, 3 phase

TRACTION DRIVE

Hydrostatic Four Wheel Drive
Gradeability - 25%

STEERING

Skid Steer - turns on own centre

HYDRAULICS

Pump - load sensing, variable displacement
Valves - closed centre, full proportionality
remote operation, electro-hydraulic

DIMENSIONS

Weight - 10,000 lbs. (4545 kg)
Height - 78" (1981 mm)
Width - 48" (1219 mm) with tires
- 30" (762 mm) without traction drive motors
Length (Tramming) - 144" (3657 mm)
Ground Clearance - 8" (203 mm)
Speed - 1.5 m.p.h. maximum

BOOM

Hammer - TR200 with extension carriage
- TR400
Maximum reach to back - 20 ft. (5.08 M)
Hammer Tilt - Rock breaking and scaling capability
Boom Extension - 50" (1270 mm) - parallel
Slew - 360°

CONTROLS

Full proportional control over all functions from operator held remote control box.

STABILIZERS

Removable, spreading, fold down, landing gear type design.

3. PRELIMINARY DESIGN CONCEPTS

Utilizing the preliminary design criteria and preliminary specifications, it was necessary to begin conceptual layouts.

Several conceptual layouts were investigated but two surfaced as being the most viable alternatives. Refer to SD-0421-B, SD-0375/1 in Appendix "A".

These two conceptual developments both meet the design criteria but differ in the method that they achieve boom extension. In SD-0375/1, a single vertical link provides an intermediate member to achieve boom extension while parallel movement is attained by hydraulically linking the boom extension cylinder and the boom lift cylinder. This is a proven method of achieving parallel boom movement while the boom is extending.

In SD-0421, two vertical links of equal length provide intermediate members between carrier and boom, and the parallel links provide the boom with a mechanical method of boom parallelism while extending the boom.

This method is superior to the other in two ways:

A) It produces parallelism by mechanical means in a simple manner.

B) Inherent in the design, it provides a structure which is torsionally more rigid.

Based on this observation, it was decided to pursue the boom configuration of SD-0421.

Three "thumbnail" sketches exhibit potential uses for this unit. Refer to Appendix "A", Sketches 1, 3, 4.

4. PATENT SEARCH

Documentation and layouts were submitted to initiate a patent search on the selected concept.

Feedback was positive, in that the concept did not infringe on any existing patents however the concept was not patentable.

5. SCHEDULE

In co-operation with manufacturing and engineering, a schedule was developed to provide a base of activity vs time.

6. DESIGN LAYOUTS

A) Weight Distribution and Centre of Gravity:

It was recognized immediately that a machine of this configuration could have serious weight distribution problems, due to the small weight ratio between boom and chassis in conjunction with an extremely long boom reach relative to chassis size. Therefore it was at this point that a targeted centre of gravity in the tramming position would be the centre line between the tires or a 50/50 weight distribution. This would allow the unit to optimize tractive effort as it was to be of four wheel drive configuration as well as bidirectional. Therefore it's performance from a tractive effort standpoint would be equal in either direction.

It was also decided that with the boom fully extended, stabilizers outstretched, that the centre of gravity from the boom end stabilizer could be no less than 34% of the total distance between the two stabilizers. Refer to SK-2 in Appendix "A". A number of centre of gravity component layout sketches and calculations were completed. Refer to SK-3 in Appendix "A". It was noted that a counterweight of significant size would be required to achieve these goals. It was understood that the counterweight would be fitted at the rear of the slewing turntable, to remain as a constant resisting the overturning moment when slewing the boom assembly.

B) Boom Extension:

With the mechanical parallel link boom extension alternative selected, it was necessary to attain a stroke of 50". While this alternative maintained the boom parallelism, there was a vertical movement of the boom due to the arc in which the parallel links would swing. This vertical displacement was decided to be minimal performance shortcoming and could be overcome by the operator.

To assure a 50" stroke and remain practical in terms of link arc angle and height consideration, an arc of 84° at centre distance of 41" was selected to meet all considerations. Mechanical stops could be fitted at a later date if deemed necessary.

C) Boom Hoist Bellcrank:

In order to maximize coverage of the boom not only from a back reach condition but also from a downreach

condition a method of hoisting the boom through a total arc of 160° was desirable.

A method of achieving this was with the use of two cylinders and a bellcrank link. This bellcrank link effectively created a floating pivot for the secondary cylinder positioned by the primary cylinder. It was felt that the operator could control these cylinders individually or in the case where a specific application required only limited boom movement, a solid adjustable link could replace one of the cylinders maintaining a specific coverage range for boom movement.

With the two cylinders in place it was possible to achieve a total arc swing of 164°.

D) Feed Extension:

As an added feature to compliment the boom for operation ease, it was advantageous to add a parallel feed extension at the hydraulic breaker. This was to be offered only with the 1 of the 2 breakers selected, being the Teledyne Roxon 200 (Refer to Appendix "H") due to weight considerations. It was felt that with a bare "TR200" breaker weight of 700 pounds combined with a robust slide and breaker mounting arrangement, that the combined weight would approach the maximum criteria weight of 1500 lbs.

This would not allow a slide extension to be fitted to a "Teledyne Roxon 400" (Refer to Appendix "H"). A bare weight of 950 lbs. with a feed extension would exceed the intial design parameters of 1500 lbs.

It was decided that a "TR200" hammer fitted with a slide extension would handle over 90% of scaling operations as a function of impact energy and the "TR400" would be primarily used in the breaking mode where a feed extension can be simulated with other boom movements.

E) Slewing:

To obtain 360° horizontal boom rotation, a method of supporting the boom as well as a method of full rotating capabilities was required. A "Rotek" bearing was selected with internal spur gear teeth hobbed in the inner race to provde a method of rotation. The width of the outer race was within the maximum envelope size and the load rating provided a turning moment rated safety factor of 2:5:1. The method to provide rotation was a high torque, slow speed hydraulic motor combined with a pinion gear to mesh with the slew bearing inner race gear teeth.

F) Booms, Parallel Links, Base Mounting Pivots:

Fabricated components were designed to Teledyne boom standards with standard pivot configurations, being pins and hardened bushings. Being closely related to the rock breaker boom configuration it was felt that the expertise developed with the rock breaker and previous scaling booms was an acceptable method in the design of this scaler's boom assemblies.

G) Carrier:

The carrier was to be extremely compact, in terms of width (48" with tires and 30" without tires). It was necessary to fit componentry within these parameters, realizing weight and serviceability considerations. Wheel motors were selected on two considerations, primarily being each motor could be no wider from mounting face to outer hub face than nine inches. After the wheel motors met this criteria, a selection was based on required torque, speed, etc., to meet further criteria.

The carrier had to support the weight of the boom assembly as well as induced loads produced by scaling and breaking.

H) Stabilizers:

Four independently operated stabilizers were required to reduce the overturning moment produced by the extremely long boom reach. It was necessary that they be compact in design, must fit within the 30 inch width restriction, yet spread to as great a width as possible to stabilize when slewing. A configuration to spread and extend met the design criteria in terms of weight distribution and centre of gravity calculations. This configuration provided a spread width of 72 inches and a length of 120 inches. This was a significant stability zone increase over the tramming mode with a 48 inch width and 40 inch length. (Wheelbase)

I) Electric Motor and Hydraulic Pump Location:

It was recognized that the primary working orientation of the boom would be 45° each side of carrier centreline. As a result of centre of gravity calculations, the motor and pump represented a considerable mass to resist the induced overturning moment created by the extended boom. Therefore the motor/pump combination were located at the rear of the carrier.

J) Tramming:

Being of skid steer configuration, it was not only necessary to meet gradeability criteria, but also to provide enough tractive effort to overcome the resistant forces due to skidding the tires. It is well known that skid steer vehicles are of the "oversquare" configuration, being that the track width is in excess of the wheelbase. This simply provides a greater tractive effort moment than the resistant moment due to skidding, thus allowing the vehicle to skid, providing the torque is adequate. Calculations were performed to optimize steering capabilities based on weight distribution, tractive effort with an oversquare ration of 1:2:1 (48 inch track width, 40 inch wheelbase).

It was also recognized that conditions may exist when the tractive effort or ground clearance is not adequate rendering the unit immobile. It was decided to add the capability of raking the boom while tramming and thus allowing the unit to pull itself up extreme grades of poor tractive conditions or over large oversize, thus exhibiting capabilities of entering areas only accessible by much larger or more powerful equipment.

This capability of boom raking would also allow the unit to propel itself with the wheel motors and tires removed, thus allowing the unit to enter extremely narrow areas as small as 30 inches wide while skidding on the carrier.

7. SYSTEMS ANALYSIS

A) Hydraulic System:

Ultimately, the objective of the "Hydraulic Mini Scaler" was to perform the scaling operation mechanically with the dexterity of a man using a scaler bar but in a safer, more productive manner. With this objective in mind, it was recognized that a sophisticated hydraulic system with full proportionality characterisitics operated from a remote control unit was required if the unit was to be operator acceptable.

Therefore, system selection was directed towards a closed centre, electro-hydraulic, pilot assisted, fully proportional, load sensing control valve. This valve in oversimplification converted variable electrical inputs into variable hydraulic oil flow outputs as a function decided by the electronic controllers. This

produced the proportionality required to achieve the required characteristics. Load sensing was chosen to optimize system performance in terms of heat rejection.

Pump selection, based on maximum flow and pressure for the rated RPM also required other features being:

i) Load Sensing;
ii) Variable displacement;
iii) Contamination tolerant.

Proportionality was provided for all boom and tramming functions. Stabilizers, being infrequently used and to a degree, non-critical, were to be controlled by a non-proportional, electro-hydraulic valve, fitted with flow controls to adjust extension and retraction speed. It was decided to add an oil cooler sized to nominally reject 25% of total horsepower required by the "TR200" breaker.

The traction drive (wheel motor) was to be of open loop configuration, wheel motors being in parallel, side to side on the unit to produce the skid steer turning momemts required.

B) Electrical System:

The electrical system was to meet NEMA 4 and electrical code requirements in addition to mining code requirements. The primary function was to provide power to the 30 h.p. electric motor drive. Secondary functions were to provide:

i) Power for lighting;
ii) Power for the remote control unit.

The system was to include allowance for a pilot wire type ground fault system.

Due to the operating environment, the remote control unit was to be powered by a 12 VDC system. This meant a step down from 600 VAC to 12 VDC.

C) Remote Control System:

It was necessary to develop logistics in conjunction with the electro-hydraulic system development. A system of operator controls using three dual axis, variable output, joysticks in combination with a selector switch providing for three modes of operation being:

i) Stabilizer mode;
ii) Boom mode;
iii) Tramming mode.

In the stabilizer mode, it was possible to operate stabilizers only. These stabilizers could be extended and retracted individually to allow front/rear and side/side levelling capability.

In the boom mode, it was possible to operate all boom functions individually. Each of the following functions was fully proportional:

i) Boom extend/retract
ii) Boom hoist 1
iii) Boom hoist 2
iv) Slew
v) Dipper
vi) Breaker tilt
vii) Breaker feed extension
viii) Breaker activate (non-proportional) singleacting.

Thus fifteen functions were remotely controlled, eleven of them being proportional.

In addition a remote emergency shutdown located on the remote control unit provided a safety precaution, if for any reason the power supply to the remote control unit was lost, the complete scaler would shut down.

8. DESIGN AND SYSTEMS REVIEW

At this point progress was sufficient that a review of the design vs. the initial design criteria and specifications was necessary.

This involved engineering presenting the preliminary groundwork to the marketing, manufacturing and service departments.

The preliminary specifications were reviewed and it was demonstrated how the unit would achieve the stipulated performance.

A number of areas were of concern in terms of manufacturing problems and performance. It was realized that slewing the unit 360° without the use of electrical slip rings or hydraulic rotary valves would lead to premature failure of hydraulic hoses and electrical wiring. It was also realized that the counterweighting required could be substantially reduced by limiting the slew angle to 45° each side of centre.

As all scaling operations could be performed within 45° from centre line, it was evident that the cost/complexity vs. benefit ratio did not warrant the 360° rotation requiring the use of electrical slip rings or hydraulic rotary valve. Therefore the slew would be limited to 90°, 45° each side of centre.

The traction circuit of the hydraulic system, being of open loop design, relied solely on the valve spool for dynamic and static braking with no relief protection. It was therefore decided to integrate a motion control valve into each traction circuit, thus providing closed loop characteristics from an open loop circuit.

The boom coverage proposed exceeded initial criteria and therefore was deemed acceptable.

There was concern expressed about the complexity of the control package due to using an unorthadox three dual axis joystick controllers. This was presented as the most practical method of control given the time allotted for development.

It was established that the preliminary design criteria and specifications were acceptable and that the unit as proposed could meet the criteria with the exception of slewing angle.

9. DETAIL DESIGN

After an acceptable design review, further detailed layouts and calculations were necessary to estimate anticipated loadings under various conditions. Based on these estimates detailed engineering calculations were carried out for the following areas:

A) Carrier structural analysis;

B) Boom structural analysis;

C) Cylinder geometry, loading and sizes, boom and stabilizers;

D) Pivot and bushing sizes;

E) Breaker extension carriage loading;

F) Turntable structural analysis;

G) Gradeability analysis.

10. DETAIL SYSTEMS

Detail design and development of the three major systems were approached by schematics. The criteria as presented in system analysis provided the framework to develop the schematics. Refer to Appendix "B" for the following schematics:

A) Hydraulic Schematic;

B) Motor Control Schematic/General Electrical Schematic;

C) Remote Control Unit Schematic

11. SPECIFY AND SOURCE PROPRIETARY COMPONENTS

Due to the extreme specialization of many of the proprietary components, many of them manufactured to order, it was necessary to pre-release these items due to extremely long lead time in terms of project time frame. The following is a list of major proprietary components. Details as per their manufacturing specifications etc. may be found in Appendix "C".

A) Wheel motor

B) Boom/Traction Control Valve

C) Hydraulic pump (Main)

D) Hydraulic pump (Secondary)

E) Flow divider/combiner

F) Slew hydraulic motor

G) Dual axis joystick controllers

12. DETAIL SKETCHES, DRAWINGS, ASSEMBLIES

With design layouts completed, detail sketches were primarily used. Where the need for scale drawings, templates or assemblies occurred, as in the case of

the carrier weldment, the drawing was completed. Material lists were documented for material procurement.

13. ORDER COMPONENTRY AND RAW MATERIAL

Material lists were issued to Purchasing for material, hardware and miscellaneous procurement.

14. FABRICATE COMPONENTS

Major assemblies were released to fabrication shop for component fabrication. There were a number of manufacturing problems associated with this unit primarily due to heat distortion from welding. The following is a partial list:

A) Slew bearing mounting faces on carrier and turntable weldment were dished due to heat distortion. These complete assemblies were milled to a flatness tolerance acceptable for bearing mounting.

B) Parallel links torsionally twisted due to heat distortion. Links were overbored to realign to parallelism tolerances.

C) Breaker Extension Carriage slide surface pulled due to heat distortion. Bearing blocks and slide surfaced were re-machined to provide acceptable slide.

15. ASSEMBLE PROTOTYPE

Prototype assembly was completed with minor rework. The area which presented the greatest challenge was the carrier unit hydraulic plumbing. This was due to the high intensity of hydraulic components to be integrated in an extremely compact area. Routing hoses and electrical wiring through the slew area was extremely critical with a support ring to hold them at the apex. The boom control valve location significantly effected the hose life in the slew area. This was primarily due to the large lateral movements of the boom parallel link extension (50 inches).

Control systems were interfaced with hydraulic system components. Due to the poor resistance of variable displacement piston pumps to contamination, the unit was flushed and run by means of a portable power pack with a high volume filtration package (10 micron).

16. SHOP TESTING

Initial startup brought a number of problems primarily dealing with the hydraulic system. Troubleshooting indicated that an incorrect hydraulic pump was shipped,

being a pressure compensated pump only and not load sensing. Pilot spool sections and load sense lines required individual bleeding to remove air "pocketing".

Cycling tests and simulated field test trials were performed to evaluate performance and systems interface.

17. MINESITE TEST LOCATION

Kiena Mine, Val D'Or, P.Q. was interested in a diesel/electric powered, truck mounted scaler to suit their vigorous operating conditions.

We decided to test the prototype at Kiena as it represented the toughest operating conditions and partly due to an established working relationship. A series of meetings led to an agreement for testing the unit.

The scaling tests in production stopes were to be evaluated from a production and operator safety standpoint.

To properly outfit the machine to Kiena's operation, it was agreed that a number of changes and additions were required. This initiated a rework program dealing with the following areas:

A) Tire Size and Ground Clearance:

It was necessary to increase both the tire size as well as the ground clearance to assure entrance into the stope. Oversize combined with the high entry grades to the stope, was beyond the capability of the unit in its original state.

B) Trailing Cable Retraction:

To provide maximum operator protection and convenience a self retracting cable reel was to be machine mounted.

C) Mobility:

It was agreed to attempt moving the machine from stope to stope in a 5 yard scoop bucket.

D) Lighting:

Suitable lighting was to be fitted to allow full range visibility at the breaker shank as well as the area behind the unit for exiting the stope.

18. PROTOTYPE RE-WORK

The three major areas which required rework of the "Hydraulic Mini Scaler" to Kiena's requirements were:

A) Ground Clearance:

In order to increase the tire size it was also necessary to increase the track width. This was due to interference with the stabilizer legs in the spread position. Therefore, a removable mounting extension for the wheel motor mountings increased the track width to 62" and in conjunction with the larger tires (8.25 x 15) increased the ground clearance to 13 inches from 8 inches.

B) Cable Reel:

A self retracting cable reel capable of storing 220 feet of #8 GGC trailing cable was specified. The reel was of stacked spring motor design requiring no external drive. This unit was mounted on the rear of the "Hydraulic Mini Scaler" complete with a full protection package and a roller type fairlead assembly.

C) Control Cable Boom:

A boom was fitted to the rear of the unit to carry the remote control unit cable. It was capable of swinging 60° each side of centre, following with the operator, assuring that the cable was less susceptible to being damaged.

19. FINAL SPECIFICATIONS (Per Kiena configuration)

ELECTRIC MOTOR

Output	30 h.p. (22 kW)
Voltage	575 volts (optional voltages available)
Current	31 amps
Frequency	60 Hz

DRIVE

Type	Hydrostatic Four Wheel Drive
Tires	8.25 x 15 United Sooper Scooper

STEERING

Type	Skid Steer
Turning Radius	Turns on own centre

HYDRAULICS

Main Pump	Variable displacement, load sensing
Pressure	3000 psi relief (172 bar)
Flow	22 gpm (83 lit/min.)
Pilot Circuit	6 gpm (22.7 lit/min.), 300 psi (21 bar) relief

DIMENSIONS

Weight (bare)	14,500 lbs. (6590 kg) with all options
Height	77.75" (1975 mm) standard
Width	62" (1575 mm)
Length Tramming	167.3" (4250 mm)
Ground Clearance	13" (330 mm) optional

SPEEDS

Slewing	90° in 18 sec.
Ground Speed	1.5 m.p.h. (2.43 k.p.h.)

LIGHTS

Voltage	115 vac, 2 front floodlights 150 W each, boom mounted vibration isolated 1 rear floodlight 150 W

BOOM GEOMETRY

Coverage as required within SD-0541-C
(Refer to Appendix "H")

Boom Extend	-40° to +40° 50" (1270 mm) horizontal
Boom Hoist #1	Up 37° extended Down 43° retracted
Boom Hoist #2	Up 37° extended Down 47° retracted
Combined Boom Hoist	Up 75° extended Down 90° retracted
Dipper	Up 5° extended Down 135° retracted
Hammer Tilt	Up 0° retracted Down 90° extended
Hammer Feed	18" (457 mm)

CONTROLS

Remote Control Box, operator held.
Proportional control of all boom and tram functions.
Impact resistant polycarbonate enclosure.

OPTIONS

Scaler Head	TR200 c/w extension carriage
Cable Reel	Spring motor drive, 200 ft. (60 M) trailing cable, self retracting
Protection Packages	Boom Protection Package Stabilizer Protection Package Reel Protection Package Full Skid Plate Protection Scaler Head Deflector Plates

20. FIELD TESTING

Upon completion of the rework to Kiena's configuration, two other test locations were arranged to evaluate the unit. Both of these locations were without electrical service within the range of the unit. Therefore generator sets were arranged to provide power to the unit.

One of these locations was a local limestone quarry. The evaluation and operation of the prototype was the sole responsibility of Teledyne personnel. These tests were to evaluate the following areas:

A) Rock Face Coverage

B) Scaling Performance

C) Reliability

D) Tramming Capability

E) Rockbreaking Performance

F) Operator Acceptability

G) Systems Performance

H) Demolition Performance

I) Operator Safety Zone

The other location was a reinforced concrete and structural steel building which was to be demolished.

After evaluation at these areas, changes or improvements would be initiated and upon completion the unit would be delivered to Kiena.

Quarry testing commenced September 17, 1984 for a two week period ending September 28, 1984.

Building demolition testing commenced October 3, 1984 for a 1-1/2 week period ending October 12, 1984.

After assembly underground at Kiena on October 29, 1984, it was established that transportation in a scoop bucket was not an acceptable method of transportation. Due to the non-freewheeling capability of the wheel motors (no towing capability) it was necessary to explore alternatives to transport the unit underground from level to level and from stope to stope.

It was decided to build a single axle trailer, designed for towing behind a scoop tram, utility truck, etc.

21. TRAILER TRANSPORTER

A tilt deck trailer, designed specifically for underground use was manufactured to transport the "Hydraulic Mini Scaler". The unit was not to exceed:

A) 100 inches in width
B) 110 inches in height with unit loaded

Minimum ground clearance was to be 15 inches, with a cutoff front and rear of 20% minimum. It was to be capable of carrying the total weight of the "Hydraulic Mini Scaler" and facilitate self loading and self unloading preferrably with no "tie-down" required when transporting. Refer to Appendix "E" for Trailer photographs.

Specifications as follows:

A) Capacity - 15,000 lb. payload maximum

B) Overall Weight - 4,100 lbs. (with deck counterweights - 6)

C) O/A length - 15' 2"

D) Disassembled Length - 9' 11"

E) O/A Width - 8' 2"

F) Disassembled Width - 70"

G) Deck Length - 8' 10"

H) Deck Width - 5' 4"

I) Ground Clearance - 16"

J) Height to Top of Deck - 16-1/2"

K) Tongue Clevis Height - 27"
33"
39"

L) Tires - 10.00 x 20

M) Cutoff Front & Rear - 20%

N) Loading Angle - 13° (22%)

O) Clevis End - 360° Rotation
- 2-1/4" dia. or 4" pintle eye

P) Tongue Weight as Above - 350 lbs.

Q) Available Tongue Weights - 600 lbs. (6 at 100 lbs.)

R) Gravity Tilt Deck - Suppressed Movement

SYSTEMS AND PERFORMANCE TECHNICAL DISCUSSION

1. ELECTRICAL SYSTEM

The electrical supply source is directed through 200 feet (60 M) of trailing cable (#8 GGC) to a five ring commutator housed within the cable reel. Pairs of brushes riding on commutator rings feed power (3 phases), ground (2) and ground check (1) supply lines into motor control panel. Three phase wires feed main disconnect on motor control panel, through three 60 AMP fuses to magnetic motor starter. Also two phases provide supply lines to a 575 - 115 VAC transformer. This transformer provides power for light circuit, and also to the 115 - 12 VDC power supply. This power supply is the basis for power to the RCU (Remote Control Unit).

The magnetic motor starter has an automatic overload shutdown which should never exceed a maximum setting of 35 amps. Supply is directed from motor starter directly to motor through #8 GGC cable.

The motor starter overload shutdown is also in series with the remote emergency shutdown on the RCU. Any situation which interupts the supply through this cable will either discontinue or not allow motor to operate. This supply line originates in the motor starter panel, runs through a cable to the control function junction box to the multiconductor remote cable.

The 12 VDC power supply originates in the motor control panel, runs through a cable to the control function junction box, through a cable to the multi-conductor remote cable.

When power is directed to the RCU, the white indicator light and hourmeter on the left side of the RCU will be on.

2. RCU (REMOTE CONTROL UNIT)

The RCU is supplied by a 12 VDC, 7.0 amp power supply. The input is transferred into the RCU through the multi-conductor cable. This supply is split and powers various functions within the RCU.

The RCU sendscontrol voltage signal to two types of valves.

Type 1 valve is a non-proportional solenoid valve (ON-OFF) which when solenoid is activated allows oil flow to various functions. These functions are all stabilizer funcations as well as the solenoid to shift pump to full compensation pressure when operating the breaker.

Type 2 valve is a fully proportional solenoid valve, controlled by a signal voltage through variable voltage

output controllers. The valve spools are spring centered and control voltage from 0 to +3.6 VDC moves spool in opposite direction. Each individual output may be measured at control function junction box while placing a 60 ohm resistor across signal voltage lines to duplicate coil resistance in solenoid.

A series of five relays permits the use of three joysticks to control a maximum of 10 functions depending upon mode of operation.

All boom and tramming fuctions use a Type 2 valve.

3. HYDRAULIC SYSTEM

A 30 h.p. (22 Kw) electric motor rotates directly a variable displacement axial piston, load sensing hydraulic pump (primary) and indirectly through a belt, drives a fixed displacement gear pump (secondary).

The primary pump directs oil on feedback signals by variable volume and pressure to individual functions as demanded in the closed center circuit.

The secondary pump supplies oil at a fixed displacement and pressure to the proportional type valve to assist in shifting individual spools in valve bodies in conjuction with electrical control output voltage of individual controllers.

A load sense line, which sends feedback signals from all proportional functions, and only the greatest feedback signal is fed back to the pump compensator and thus directing flow and pressure is required. This allows multi-function operation under different individual operating pressures.

A) Traction Circuit:

The traction circuit consists of two closed centre individual control valve sections, controlling four individual wheel motors operating in parallel in an open loop system (two wheel motors left, two wheel motors right).

Due to the inherent properties of an open loop, motion control valve are integrated, one for left hand, one for right hand to provide a hydrodynamic braking effect. The motion control valves also replenish the open loop in a "run on" condition to prevent cavitation and "run away" on downhill grades.

In addition to motion control valves, each side (left and right) has a flow combiner divider. This provides each wheel motor with 50% of total flow

±10% regardless of motor pressure. This provides the carrier with true four wheel drive characteristics regardless of tractive conditions. Each traction circuit spool is equipped with an overload relief.

B) Boom Circuit:

i) Slew
The slew circuit consists of one closed centre valve section, one fixed displacement hydraulic motor and a spring applied hydraulic release failsafe brake caliper for slew rotation. The spool is shifted front or back, initially building enough pressure in motor and caliper gallery to release brake and allowing motor to rotate. When spool is returned to centre, brake is re-applied to prevent creeping of slew turntable.

ii) Boom Extension
The boom extension circuit consists of one closed centre valve section, one double overcentre valve, and one hydraulic cylinder for extension and retraction. The spool is shifted front or back releasing pilot operated load check in overcentre valve and extending or retracting cylinder. When vertical links pivot overcentre, a minimum pilot pressure must be produced to assist the oil being rapidly evacuated to flow through the relief valve keeping a consistent flow throughout stroke. This functions on extension and retraction through the double overcentre valve.

iii) Boom Hoist
The boom hoist circuit consists of one closed centre valve section, one single overcentre valve and one hydraulic cylinder. The spool is shifted front or back extending or retracting cylinder. On retraction, the pressure releases pilot operated load check in overcentre valve and pilot pressure assists in shifting relief valve to direct flow of rapidly evacuated oil, through the relief valve keeping a consistent flow throughout drop of boom.

iv) Dipper
The dipper circuit consists of one closed centre valve section and one hydraulic cylinder. The spool is shifted front or back extending or retracting cylinder.

v) Hammer Tilt
The hammer tilt circuit consists of one closed centre valve section and one hydraulic cylinder. The spool is shifted front or back extending or retracting cylinder.

vi) Breaker Feed

The breaker feed circuit consists of one closed centre valve section and one hydraulic cylinder. The spool is shifted front or back extending or retracting cylinder.

NOTE: All boom functions other than slew have individual and adjustable overload relief valves, full load sensing feedback signals.

vii) Breaker Operation

Breaker operation consists of one closed centre valve section, one hydraulic breaker and one non-proportional valve section.

When breaker switch is activated, an electrical current of 3.6 VDC @ 60 MA travels to the proportional solenoid valve section. Also a relay opens one non-proportional valve spool opening the loop between the load sense feedback line and the primary pump outlet. This shifts the compensator in the pump to maximum, producing full displacement of pump at maximum swash plate angle whenever the hammer is fired. This in effect produces fixed displacement pump characteristics in hammer fire condition.

C) Stabilizers:

Stabilizer circuit consists of four non-proportional (OFF-ON) closed centre valve sections, four hydraulic cylinders, one for each stabilizer.

Because this valve is non-load sensing, it is necessary to open the loop between the load sense feedback line and the primary pump outlet. As in the hammer fire condition, the non-proportional valve spool opens the loop, whenever selector switch is turned to stabilizer mode. Thus characteristics of a fixed displacement pump operating at full compensator pressure is demanded of the pump, but with no flow when the spools are in neutral position.

D) Filtration:

Filtration through a 10 micron composite pressure filter on the pressure line of the secondary pump continuously filters full secondary pump flow.

E) Cooling:

Cooling is attained through an oil to air heat exchanger mounted on the rear section of the hydraulic motor. Flow is continuous through return line on secondary pump. This cooler is a no by pass type design.

4. PERFORMANCE UNDER SHOP TESTING

Shop testing was performed to compare unit to final specifications:

A) Hydraulic System:

i) Hydraulic Pump

The Hydraulic pump compensator spool was set to 3000 psi to assure that maximum system pressure could be attained. The load sense differential pressure was set to operate 200 psi over required pressure. This differential increase assures that the pump will always produce 200 psi more pressure than required at the function. The volume limiter on the pump swash plate was adjusted to obtain maximum rated flow output specified.

ii) Control Valves

Control valve spool limiters were adjusted to regulate maximum flow that was available to individual functions thus controlling function speed. Each function was moved through total cycle to record pressure vs. position.

It was realized at this point that the boom hoist secondary cylinder exhibited high pressure based on system relief due to poor mechanical advantage at retracted position.

iii) Temperature Stabilization

The machine was cycled under various operating modes to record temperature of hydraulic oil. This would establish a rough limiting ambient termperature. The temperature differential under the most rigorous duty cycle was 50° F.

iv) Traction Circuit

With side to side parallel arrangement of wheel motors and rigid mountings at front and rear, tractive effort was severely limited on uneven ground conditions due to oil flowing to path of least resistance.

Therefore, it was decided to rearrange the side to side arrangement in series. This provided the tractive effort required on uneven ground but cut the output torque in half.

Therefore, a 50/50 flow divider/combiner was fitted into the parallel circuit producing the series type tractive effort characteristics with parrallel circuit torque and pressures with only marginal inefficiencies.

v) Slew

Two problems were evident due to slew configuration. The first being that at maximum system pressure the maximum side load that could be exerted at the breaker shank, with boom fully extended, was 280 pounds. This would severely limit side raking a vertical face using the slew function. It would also mean the carrier would require extra attention to levelling, for the low output torque of motor to overcome gravity component to return boom to centre line.

The second problem was holding position, either in a stationary mode with carrier not levelled or when a side load was applied at breaker shank. This was due to inherent volumetric efficiency leakby of hydraulic motor for slewing.

A spring applied, hydraulic released caliper type brake was fitted to the turntable. This method had limited acceptibility due to loss of proportional control of slewing function. The clamping force was insufficient and coefficient of friction between disc and caliper pads deteriorated with usage decreasing the system performance.

B) Physical Measurements:

i) Boom Coverage

A series of boom movements were performed and measured to confirm the specifications as per the coverage layouts. Coverage and boom movements were as per specifications.

ii) Carrier

Measurements were performed to confirm all specifications related to carrier expectation, e.g. overall height, weight distribution, etc.

iii) Control Proportionality

Data was taken to evaluate control movement vs. electrical signal output to assure consistency from control to control and axis to axis.

5. QUARRY TEST LOCATION (McKEAN QUARRIES, NOTTAWA, ONTARIO) (Refer to "Appendix F")

The quarry test was arranged to establish a preliminary performance level of the unit under a vertical wall scaling application similar to underground. The unit was fitted with the TR200 Hydraulic Breaker complete with an 18" parallel feed extension. A diesel powered generator set was rented to provide power for the unit (50 Kw, 50 KVA). It proved as an effective means of training field personnel for machine operation. The preliminary evaluation dealt

with the following areas:

A) Rock Face Coverage:

The unit was positioned in locations at various horizontal distances from the rock face and then operated to establish the optimum distance from face vs. face coverage. This test although subjective in a conclusive nature, was an effective method evaluating the coverage capabilities from a "too crowded" condition close to the face to a "too far" condition stretching the boom to its maximum.

B) Scaling Performance:

Due to the soft, deteriorated and fragmentory nature of the limestone face the breaker was "overkill" in terms of impact energy but proved to be an extremely effective method of removing loose, as opposed to picking at it with the shank. Inadequate performance of the slew was at times detrimental to overall performance.

C) Reliability:

Approximately 20 hours under actual scaling conditions were logged with no apparent failure.

D) Tramming Capabilities:

The traction drive was tested over various ground conditions and on a 25% continuous grade. The unit was capable of climbing the continuous grade at full pump displacement at approximately 85% of maximum system pressure.

E) Rockbreaking Performance:

Performance was based primarily on flexibility of boom movements. Boom coverage in the rockbreaking mode was equal to comparable 20 foot rock breaker booms with the added features of boom extension and a breaker feed extension. The limitation of a 90° slewing angle was a coverage limitation in the rockbreaking mode.

F) Operator Acceptability/System Performance/Operator Safety Zone:

The remote control unit proved to be extremely successful in terms of enhancing the operator safety zone. It was possible to position the machine within 12 feet of the rock face being scaled, and operate the machine up to 40 feet from rock face, far beyond any danger zone.

Operator acceptability of the shoulder/back supported remote control unit was marginal from an ergonomic standpoint.

Control performance, allowed full proportionality of all boom functions instilling a high confidence level in the operators of control movement vs. boom movement.

Changes proposed to improve performance was to add over centre valve on the boom extension parallel links and the boom hoist/drop.

A double, pilot operated overcentre valve was fitted to the parallel link circuit and a single pilot operated overcentre valve was added to the boom drop circuit.

Performance of these changes were to be evaluated at the demolition test location.

6. DEMOLITION TEST LOCATION (GLOBE MILLS, MEAFORD, ONTARIO) (Refer to "Appendix F")

The demolition test was arranged to establish preliminary performance levels of the unit under typical demolition/ construction site conditions. The site was a burned out building with the remaining structure consisting of reinforced concrete pillars, cement block walls, and structural steel. Reinforced pillars were up to 30 feet in height. The building fronted on the main street of the town with extremely restrictive working areas. A D3 Caterpillar was used for benching and clearing debris. The preliminary evaluation dealt with the following areas:

A) Breaking Performance:

Initially, the unit was fitted with the "TR200" hammer with the 18 inch breaker feed extension. This unit proved extremely effective for breaking concrete block walls and reinforced concrete up to 12 inches thick. To break the freestanding reinforced concrete pillars (cross-section 3 feet x 3 feet) the "TR200" breaker extension combination was replaced with the "TR400". This hammer in the 1000 ft. lb. blow energy class was extremely productive in breaking concrete of this size.

The lack of feed extension with this hammer was a detriment to overall performance.

B) Systems Performance/Operator Safety Zone/Operator Acceptability:

Reaction to this area is in alliance with the testing at the quarry site. Improved performance and control

from the boom extension and boom hoist functions due to the overcentre valves being added to each circuit.

C) Demolition Performance:

Demolition performance was based on a standard tractor/loader/backoe combination (Case 580) replacing the bucket with the equivalent Teledyne Hydraulic Breaker. The "Mini Hydraulic Scaler" exceeded the backhoe unit in terms of full extend reach as well as back reach. The scaler's performance was superior in terms of breaker feeding, utilizing the boom extension and function the breaker feed extension function with the TR200 breaker. The backhoe unit was susceptible to debris when operating at maximum height, thus leaving the operator in the danger zone. As a result of debris causing minor damage to the unit a number of protection packages were proposed to be fitted before shipping to Kiena for further testing. The following areas were fully protected:

i) Boom
ii) Stabilizers (boom end only)
iii) Cable reel protection
iv) Scaler head deflectors
v) Control valves

7. SCALING PERFORMANCE - UNDERGROUND (Refer to Appendix "F")
(MINE D'OR KIENA, VAL D'OR, QUEBEC)

The "Hydraulic Mini Scaler" was to be tested in production stopes, scaling sidewalls, faces and backs in areas up to 10 M wide and 8 M high.

In co-operation with Kiena, it was agreed that they would submit a report rating the performance of the unit. The following is a summary of our observations based on tests at Kiena.

A) Operator was able to scale large areas from one position with the ability to differentiate loose and solid rock by soundings.

B) Capable of safely operating and scaling areas which were otherwise dangerous by manual scaling methods.

C) TR200 breaker was an acceptable size in terms of blow energy.

D) Boom coverage combined with breaker feed extension provided adequate coverage.

E) Unit required the use of production equipment to move from level to level, thus reducing production output levels.

F) Unit was not equipped to clear a path on floor of muck or loose scalled.

G) Lighting was inadequate in some coverage areas.

H) Dust produced by scaling was excessive.

I) Overall stability of unit was inadequate on ramp grades and uneven ground.

J) Remote control unit weight was excessive and control logic complex.

K) Unit was better suited for operation in captive stopes requiring limited tramming.

CONCLUSIONS

1. GENERAL PERFORMANCE

The hydraulic mini scaler, was tested for approximately 200 hours at three test location. In summation, reaction to the unit was favourable with the following limitations:

A) Quarry Site:

The major area where a performance improvement could be implemented is the location of the breaker within the feed extension. Due to the breaker being mounted above centreline of this feed extension substructure, it limited the angle at which the breaker shank could enter the face. Refer to Appendix "G".

B) Demolition Site:

Performance at the demolition site was limited by maximum breaker height, when working on areas in excess of 25 feet in height. Benches were excavated to allow unit to reach these extremities.

C) Underground:

Verbal reports indicate that the carrier is too small for Kiena's application. Also, the electro-hydraulic drive limits the mobility for tramming over long distances. It appears that this boom arrangement fitted to a flat deck utility truck would meet Kiena's criteria.

2. SPECIFIC PERFORMANCE

A) Carrier:

The carrier as per the original design criteria, performed beyond expectations. The four wheel drive configuration in conjunction with skid steering and compact boom storage allowed the unit to be extremely manouverable, capable of working in extremely restrictive areas.

B) Stabilizers:

Stabilizer performance could be improved in three ways:

i) Cylinder extension and retraction for spreading stabilizers;
ii) Increase lift capacity;
iii) Increase in lift height;

Lift capacity was limited due to Kiena's configuration

options. At the demolition site, a larger ground contact pad with an increased lift height was desirable.

C) Boom Slewing:

Boom slewing angle of 90° was adequate for scaling operations. It was a shortcoming of the rock breaker mode providing less coverage than normally acceptable on breaker systems.

To improve performance, a radical torque increase is required for boom movement and slew raking. The drive should be integrated with a brake system.

D) Boom Extension:

Boom extension of 50 inches was adequate under all field conditions. A potential area of improvement being an increase in torsional rigidity of the parallel links.

E) Boom Hoist:

The bellcrank method of effectively doubling the swing arc of the boom provided the unit with an added flexibility in terms of coverage. Improvement could be initiated in bellcrank vs. boom geometry to optimize lift cylinder sizes.

F) Breaker Tilt:

The breaker tilt geometry was limited in angle above parallel with respect to outer boom. This angle should be increased a minimum of 30° above outer boom. Refer to Appendix "**G**".

G) Breaker Feed Extension:

The breaker feed extension was the most important single boom function utilized when scaling. The direct parallel feed at the breaker shank allowed simple positioning and scraping etc. by the operator.

H) Overall Boom Coverage:

With respect to the size of the carrier base unit, the boom coverage was generally concluded to be excellent. The multiple boom movement methods by which the breaker shank could be positioned provided the operator with many alternatives to approach each specific task.

3. GENERAL CONCLUSIONS

The hydraulic mini scaler is an acceptable unit for scaling, demolition and rock breaking. It is primarily

intended for use in captive areas with maximum reach required to 20 feet. As per field testing results, it is a unit which can provide effective mechanized scaling operations to eliminate the current inefficient and unsafe manual scaling. This mechanization can improve productivity of the scaling operation while vastly improving the safety zone of the operator.

RECOMMENDATIONS

1. To evolve the Hydraulic Mini Scaler to the next development level, the following recommendations are offered for consideration:

   A) Further testing underground in restricted headings.

   B) Further development work integrating a proven versatile boom arrangement to a number of various carrier configurations, eg. boom mounted to a flat deck utility truck for use underground.

   C) Further development of the electro-hydraulic system.

   D) Further development of the operator remote control package.

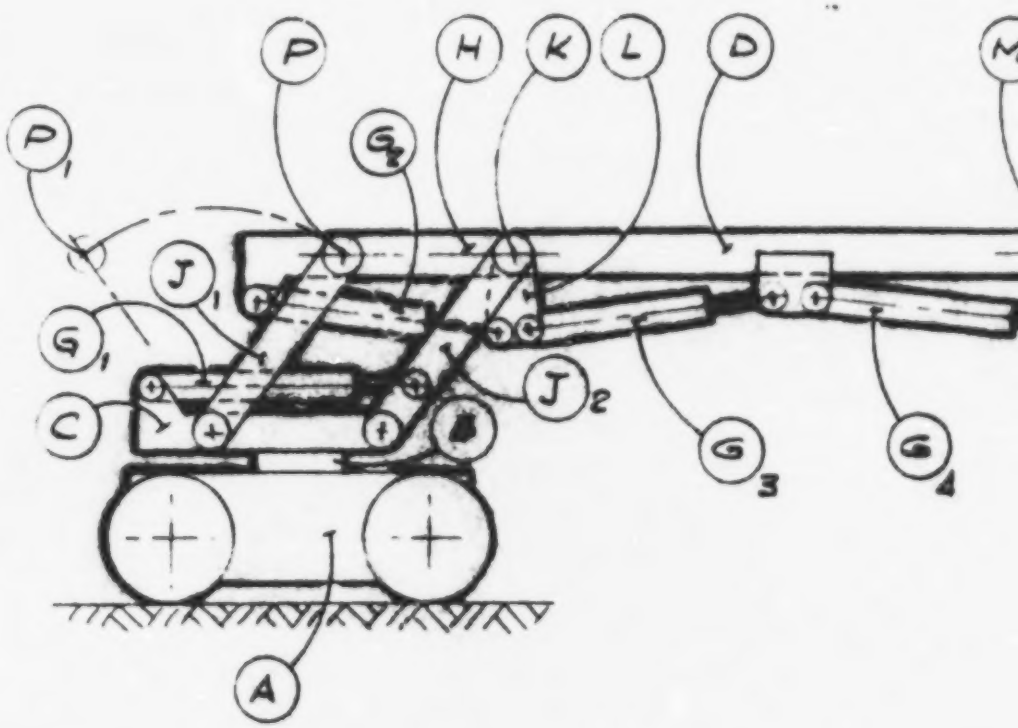
   E) Refinement of boom geometry and componentry.

   F) Further development to increase the carrier mobility.

APPENDIX "A"

SD-0421-B	Concept Layout
SD-0375/1	Concept Layout
Sketch 1	Mobile Breaker
Sketch 3	Retractory Linings
Sketch 4	Demolition
SK-2	Centre of Gravity Location
SK-3	Weight Distribution Calculation

SD 0421

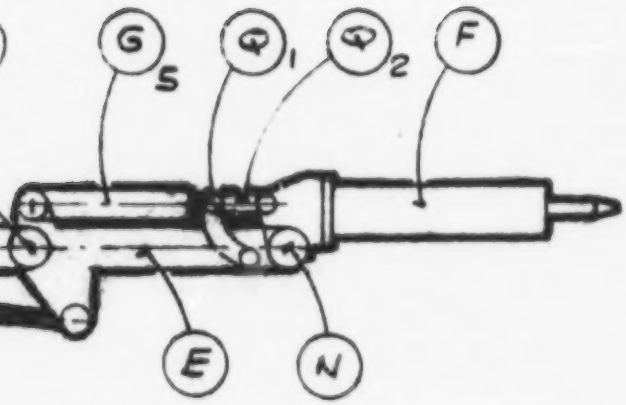


SIGNED: [signature] DATE: 31 Jan 1983

WITNESSED: [signature] DATE: 31 JAN. 1983

NO.	REVISION	DATE

50 0121



CONFIDENTIAL

ITEM	PART NO.	DESCRIPTION	MATERIAL	MATERIAL SIZE	QTY.

FABRICATION DIMENSIONS IN INCHES: UNSPECIFIED TOLERANCES ± 1/16
MACHINE DIMENSIONS IN INCHES: UNSPECIFIED TOLERANCES .0 ±1 .00 ±1 .03 .01

TELEDYNE CANADA MINING PRODUCTS — TIMMINS ONTARIO

TOOL POSITIONING BOOM SYSTEM.

DRAWN H.J.T. APP.
DATE [illegible] SCALE —
M.L. ASSY. NO.
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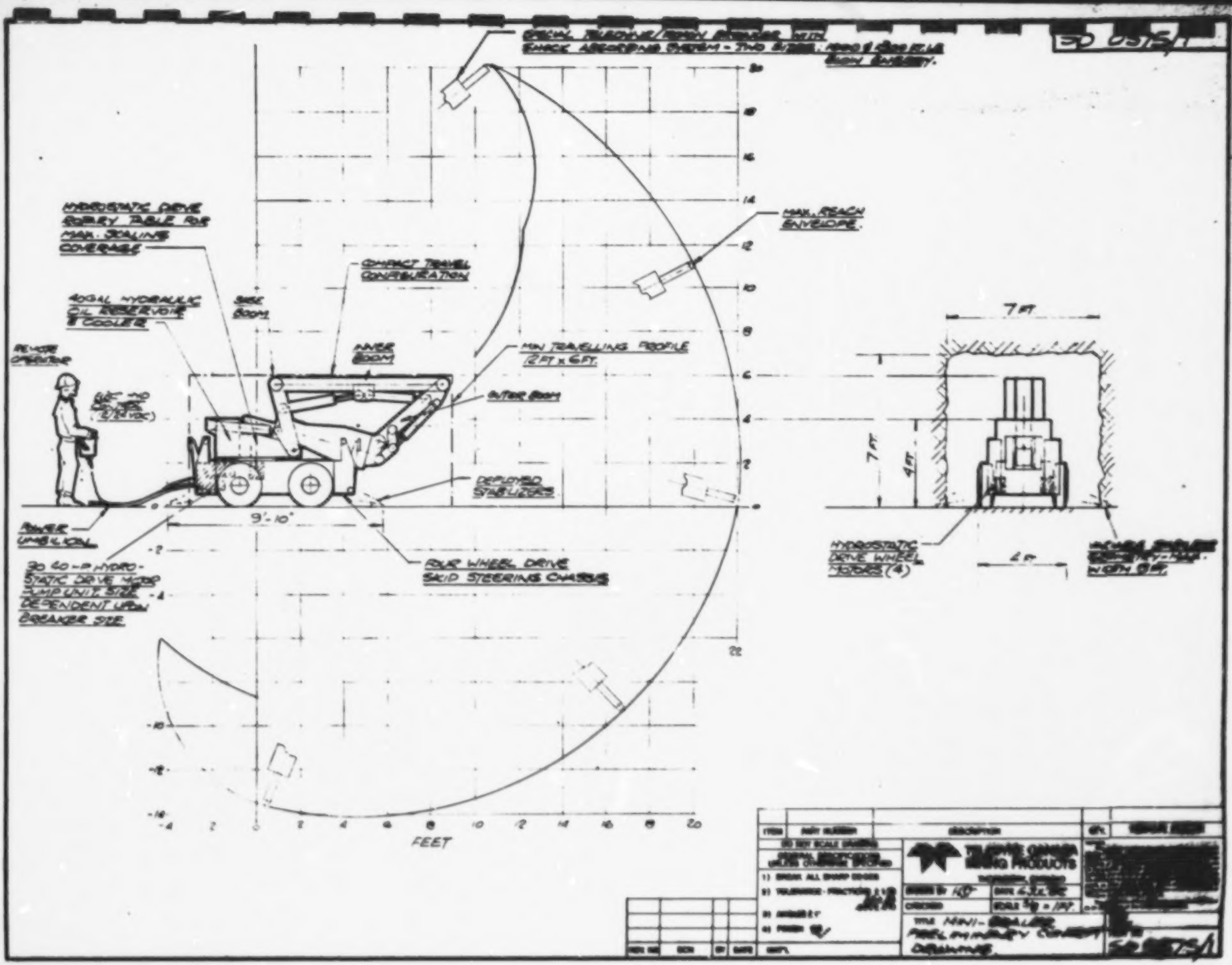
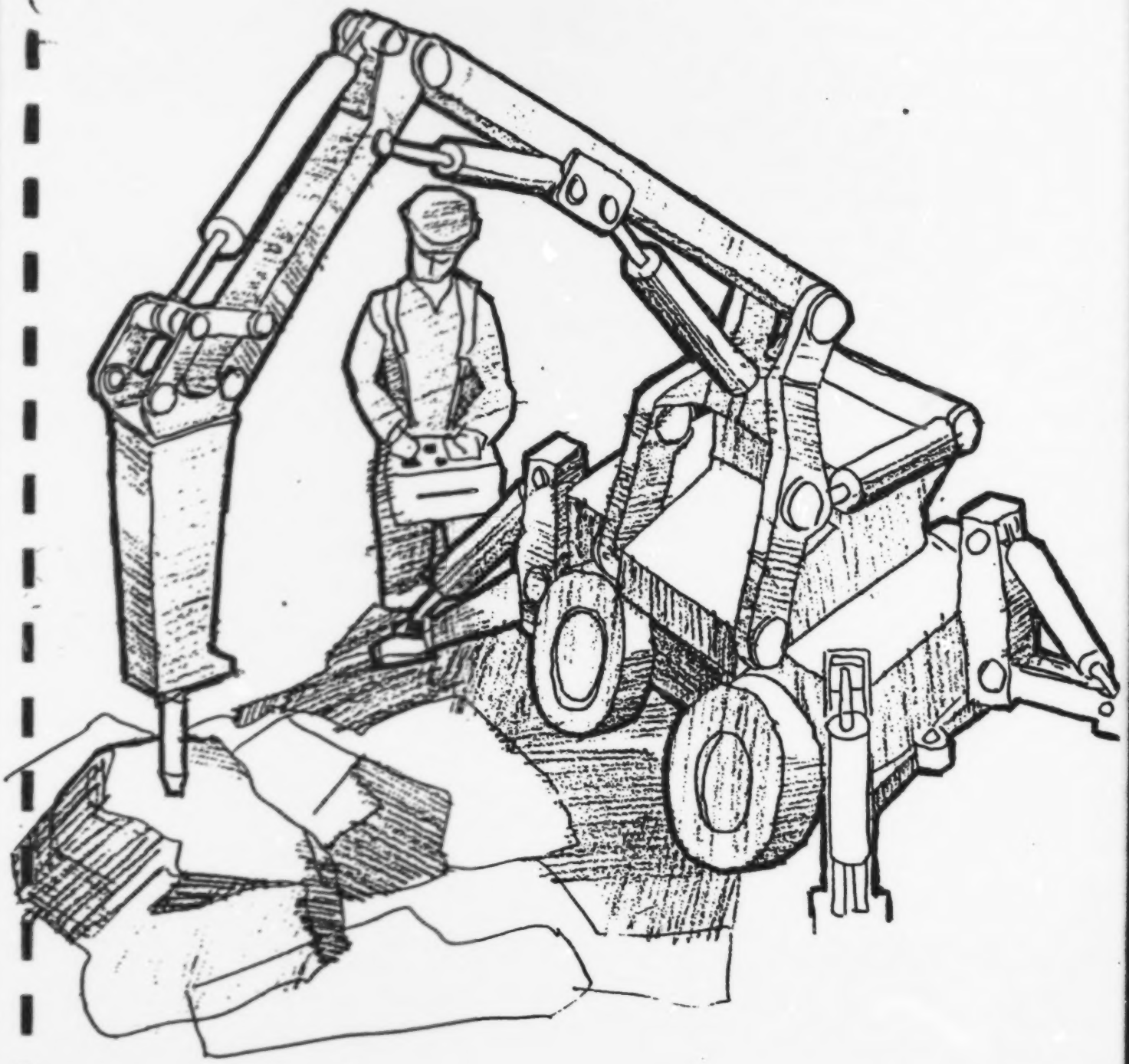

HYDROSTATIC DRIVE ROBEY TABLE FOR MAX. SCALING COVERAGE
COMPACT TRAVEL CONFIGURATION
MAX. REACH ENVELOPE
400 LT. HYDRAULIC OIL RESERVOIR & COOLER
BASE BOOM
INNER BOOM
NON TRAVELLING PROFILE 12 FT x 6 FT.
OUTER BOOM
DEPLOYED STABILIZERS
9'-10"
POWER UMBILICAL
30 GO-P HYDRO-STATIC DRIVE MOTOR PUMP UNIT SIZE DEPENDENT UPON ORDANCE SIZE
FOUR WHEEL DRIVE SKID STEERING CHASSIS
FEET
7 FT
7 FT
4 FT
4 FT
HYDROSTATIC DRIVE WHEEL MOTORS (4)

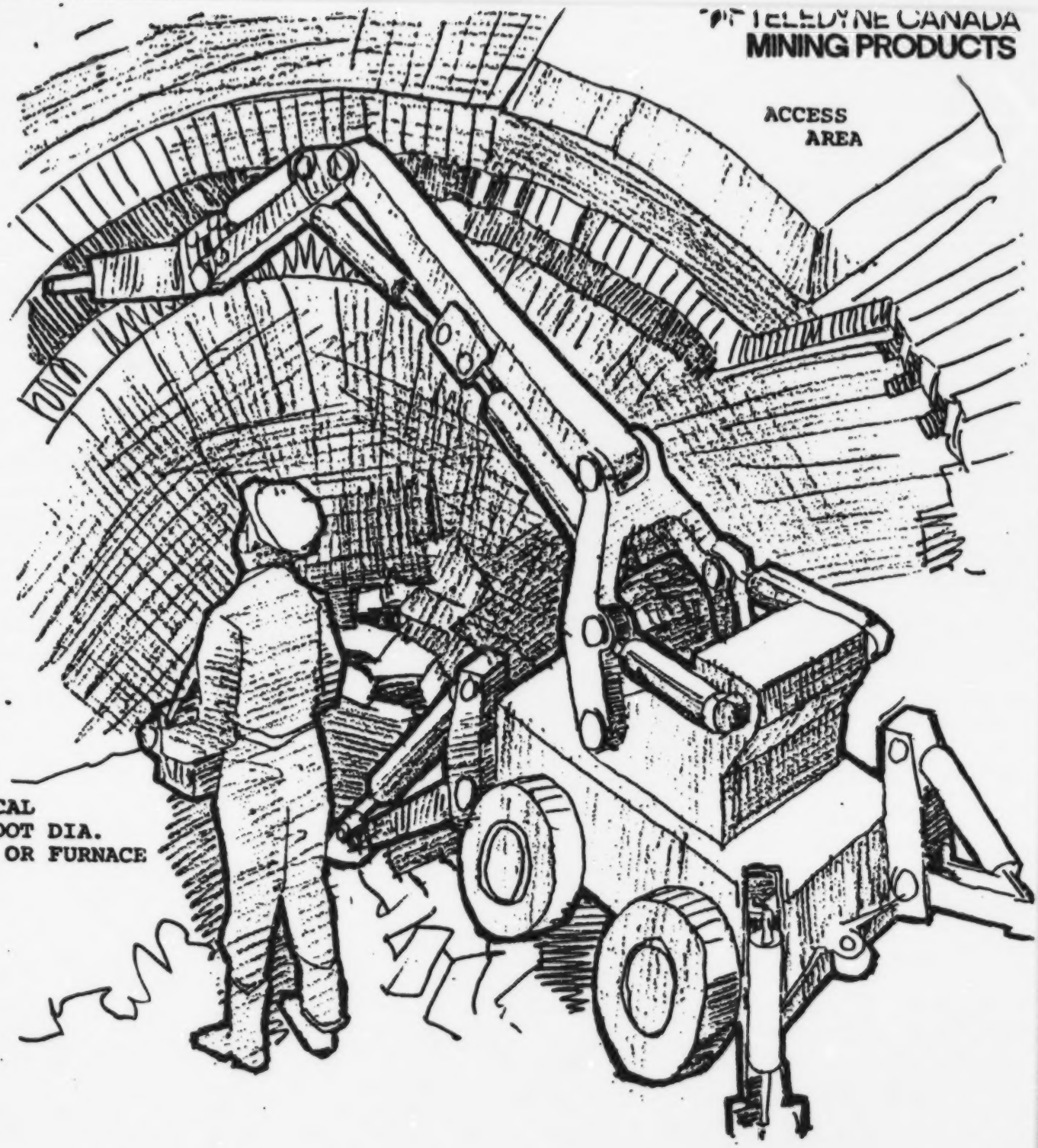


THE MACHINE CAN ALSO BE USED AS A MOBILE ROCK BREAKER FOR BREAKING OVERSIZE AND SCALED MATERIAL. PARTICULAR APPLICATIONS WILL BE IN SMALL HEADINGS OF 8 FT. X 8 FT. WHERE CONVENTIONAL MOBILE ROCK BREAKERS CANNOT BE USED DUE TO THEIR LARGE SIZE.

CA

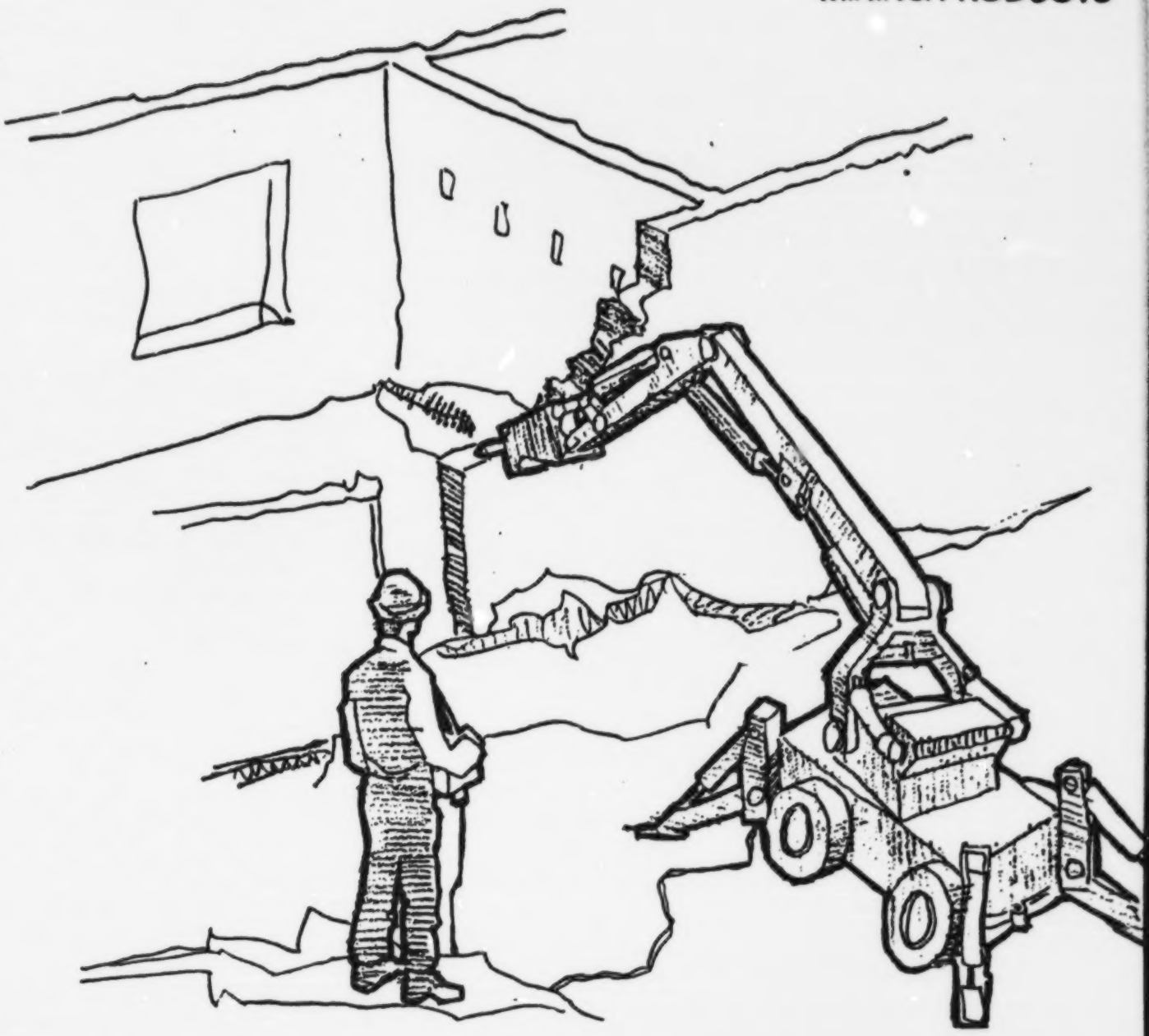
SKETCH 1 MOBILE BREAKER

TELEDYNE CANADA
MINING PRODUCTS



DUE TO ITS COMPACT SIZE, THE UNIT CAN BE LOWERED THROUGH ACCESS APERTURES IN KILNS AND FURNACES AND EFFECTIVELY USED TO REMOVE REFRACTORY LININGS. SIMILARLY, THE MACHINE CAN BE APPLIED TO BREAKING SLAG AND REVERTS IN THE METALLURGICAL INDUSTRY.

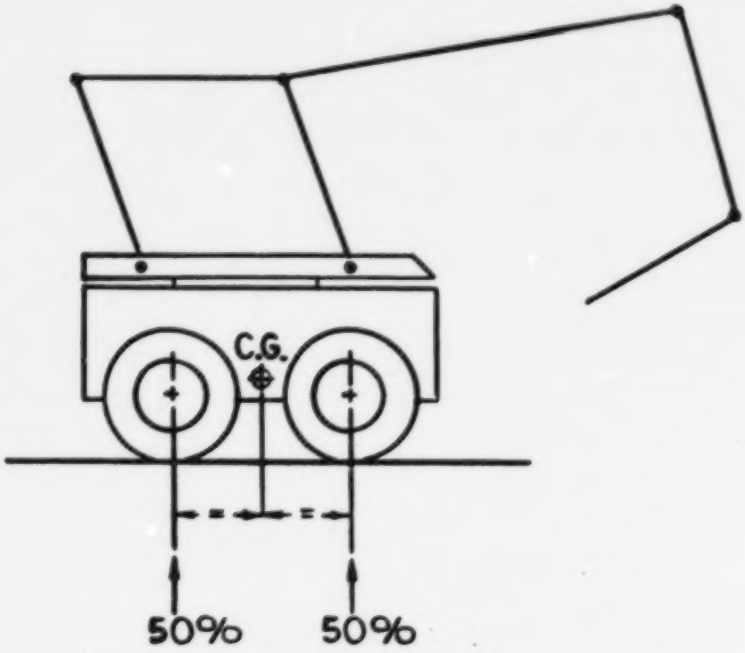
SKETCH 3 REFRACTORY LININGS



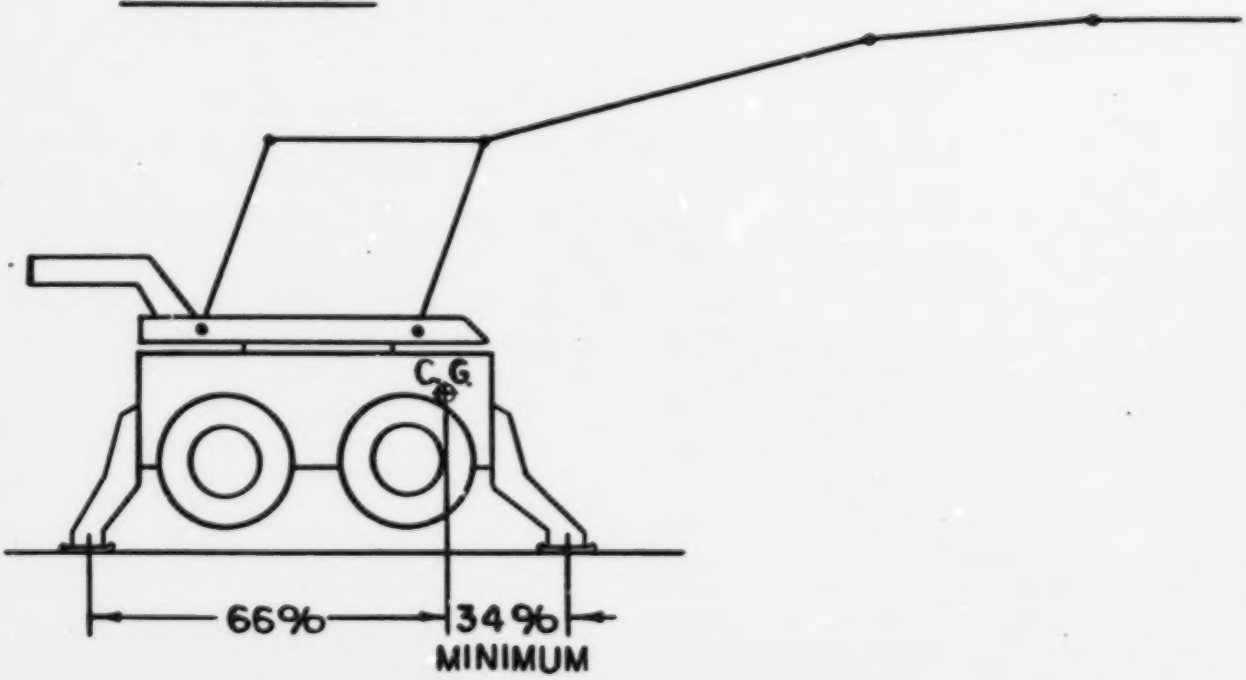
IN THE DEMOLITION OF OLD BRICK AND CONCRETE STRUCTURES AND FOUNDATIONS, THE SIZE OF THE UNIT PERMITS ITS USE IN CLOSE QUARTERS AND IT IS THEREFORE A HIGHLY FLEXIBLE AND VERSATILE DEMOLITION MACHINE.

SKETCH 4 DEMOLITION

TRAMMING POSITION



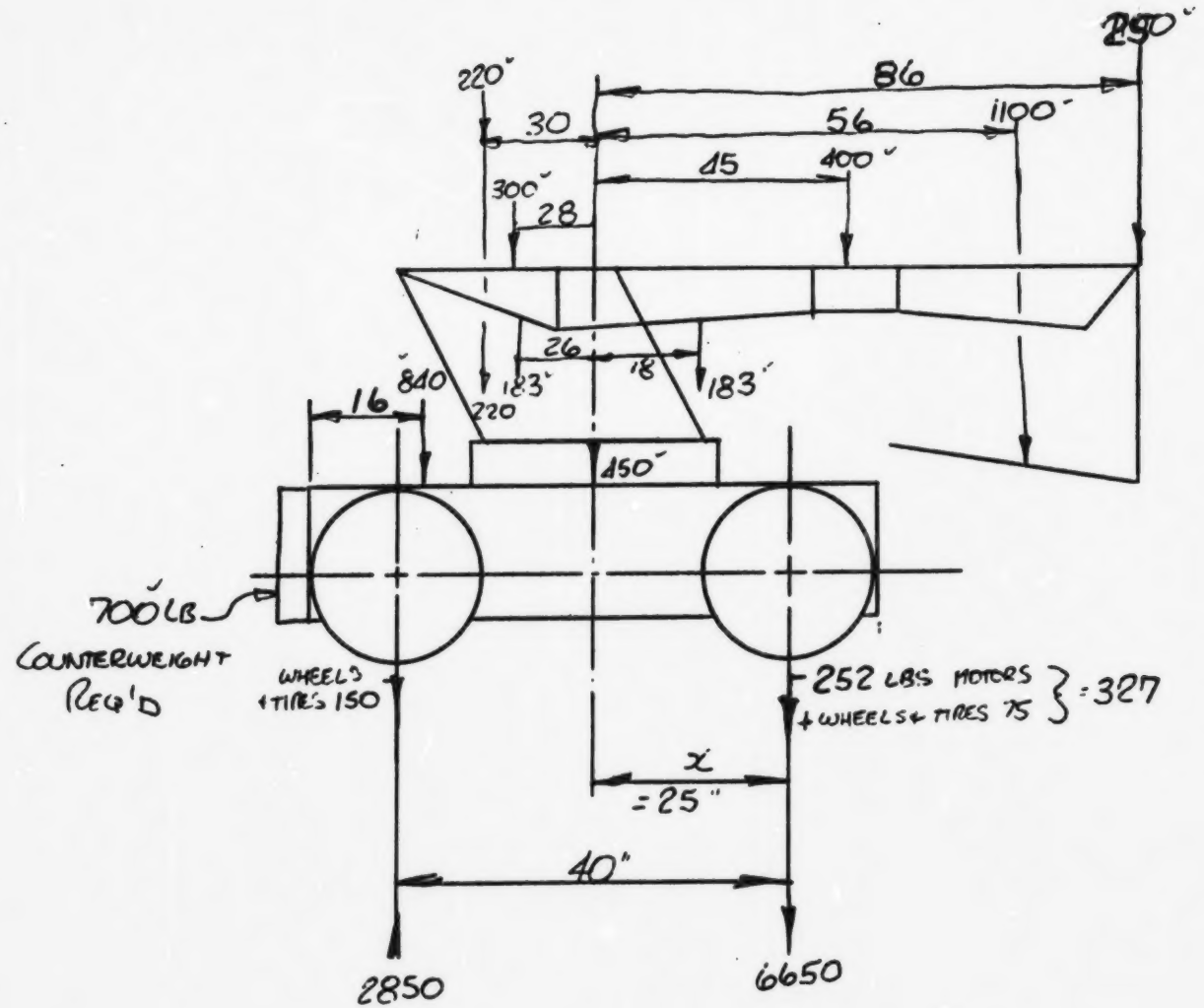
FULL REACH



TELEDYNE CANADA

SK-2 CENTRE OF GRAVITY LOCATION

CARRIER CHASSIS WT 1000 LBS @ 62.7" FROM ONE END.



SK-3 WEIGHT DISTRIBUTION CALCULATION

APPENDIX "B"

Hydraulic Schematic

Motor Control/General Electrical Schematic

Remote Control Unit Schematic

APPENDIX "C"

Wheel Motor

Boom/Traction Control Valve

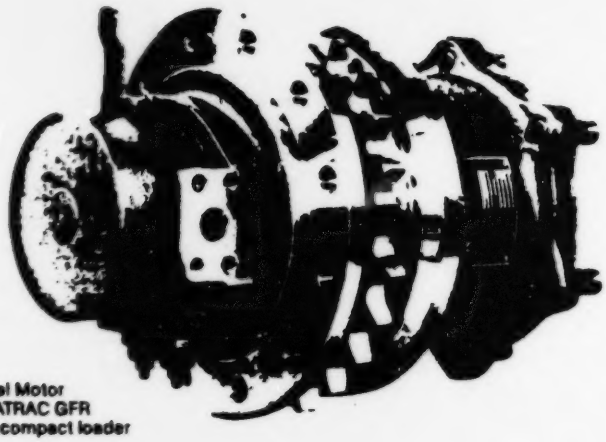
Hydraulic Pump (Main)

Hydraulic Pump (Secondary)

Flow Divider/Combiner

Slew Hydraulic Motor

Dual Axis Joystick Controllers



Wheel Motor
ROTATRAC GFR
for a compact loader

ROTATRAC GFR 048 E and GFR 053 E are a new development in wheel motor design and supplement sizes GFR 58 E – GFR 100 E which have proven their worth for many years.

The unit represents a hydrostatic single-wheel driving system which combines an axial piston hydraulic motor with a two-stage planetary gearbox.

Owing to the fact that constant displacement motors of sloping cam plate design are employed, a holding brake could be mounted on the primary side. This brake can be furnished as drum brake or as multiple plate brake.

The wheel motors are preferably used in closed hydraulic circuits where braking of the vehicle is also effected hydrostatically.

For application in open circuits L+S should be consulted to clarify some technical aspects.

Other wheel motor features attest to the well-known L+S quality standard: Hydraulic motor fabricated by Hydromatik, planetary gearbox of compact design, gear teeth having a high surface quality, external toothing case hardened, the annulus wheel of high-grade alloyed steel. Antifriction bearings which have a long service life are employed. Radial loads are taken by sturdily built taper roller bearings.

Technical Characteristics

Wheel Motors Type	Hydraulic Motor			Wheel Rim Size	Wheel Load (P) kN		Output Torque	
	Type/Size	Input speed ($n_{1\,max}$) RPM	Displacement V_g cm^3		dyn.	stat.	Permanent (T_2) da Nm	Peak ($T_{2\,max}$) da Nm
GFR 048 E	A 4 F 35	3750	35	12"+10"	30	60	250	500
GFR 053 E	A 4 F 56	3400	56	12"	40	80	400	800

Transmission Ratios Available:

i = **15,2**
17,46
20,46
25,25
28,92
34,16
42,26

Ratios printed in boldface type should preferably be selected.

Note

The built-in hydraulic motors have been designed for p of up 450 bar. The gear component can take loads of up to the specified output torques (T_2, $T_{2\,max}$). When combining these systems into a wheel motor, the permissible operating pressure is therefore governed by the transmission ratio (i) selected:

formula: $p_{zul.} = \frac{9000}{i}$ (bar),

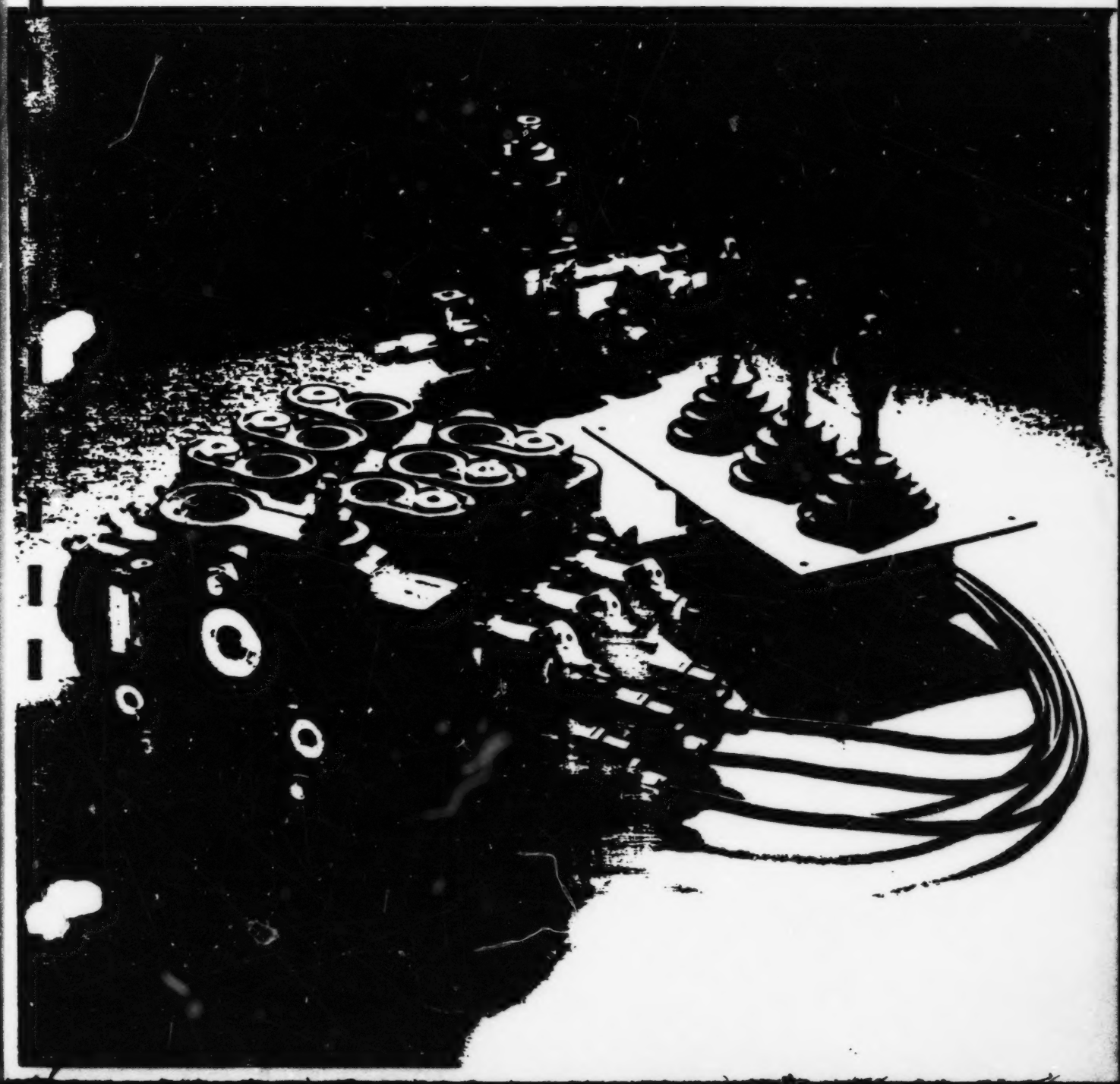
Should the desired application of the wheel motors make it necessary to modify the technical characteristics specified above, please inform us accordingly.

WHEEL MOTOR

Parker
Fluidpower

BULLETIN 1400/HB3

ELECTROHYDRAULIC PROPORTIONAL CONTROL VALVES



Sectional Assembly

The Valve That Won't Quit

ELECTROHYDRAULIC PROPORTIONAL VALVES

The fluid power future is here today at Parker where you get all the benefits of proportional remote control without the hassle.

25 micron filter is sufficient

low power requirement

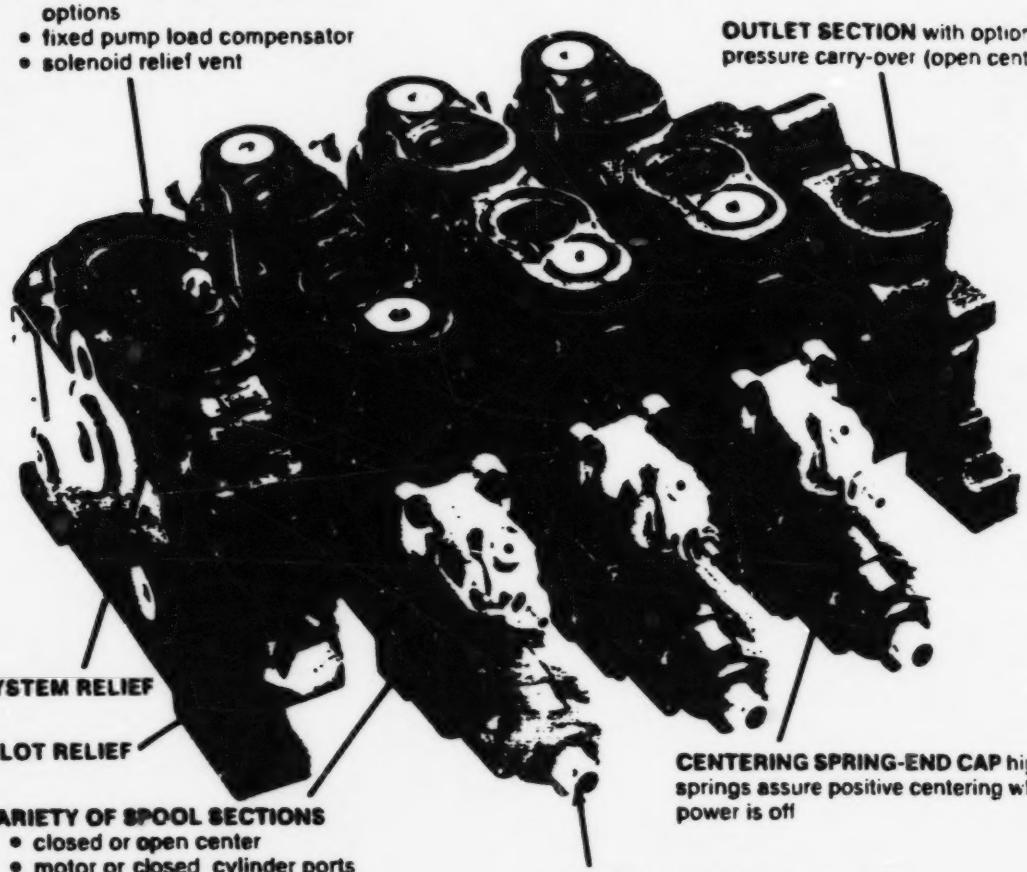
Built to live in the toughest environments

SECTIONAL STYLE VALVES

INLET SECTION with integral system relief, pilot relief and pilot strainer. Compact convenient, economical and durable.

options
- fixed pump load compensator
- solenoid relief vent

OUTLET SECTION with optional high pressure carry-over (open center unit.)



SYSTEM RELIEF

PILOT RELIEF

CENTERING SPRING-END CAP high force springs assure positive centering when power is off

VARIETY OF SPOOL SECTIONS
- closed or open center
- motor or closed cylinder ports
- 4 standard flow notches
  other options
- anti-cavitation checks
- port reliefs
- manual overrides
- spool compensator (closed ctr.)
- load sense circuitry

PILOT VALVE offers many benefits.
- 25 micron filtration
- intrinsic electrical safety is standard
- unique pilot design for reliable performance.

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Bertea Industrial Division
Costa Mesa, Calif. 92626
714.979.0771

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Basic Operation

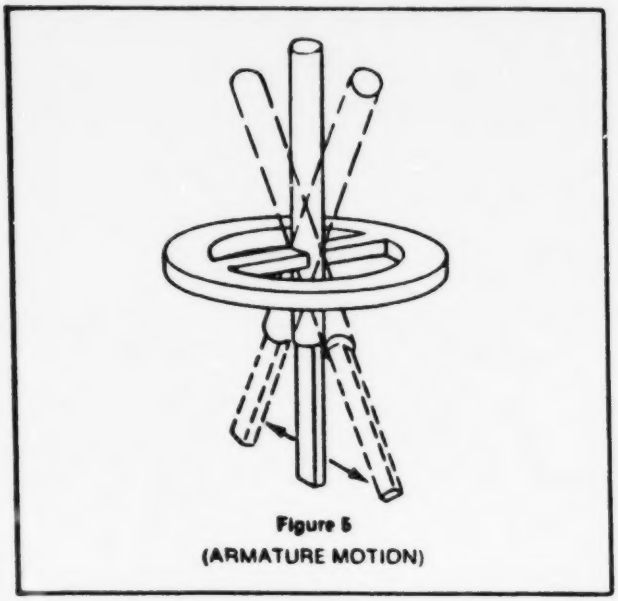

Figure 5
(ARMATURE MOTION)

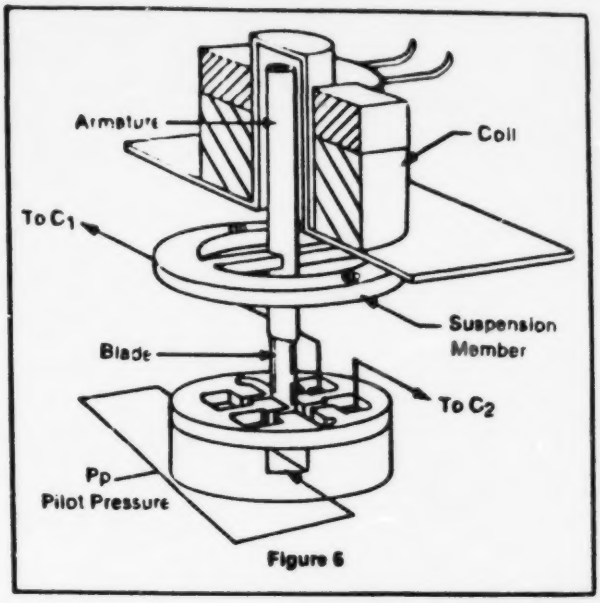

Figure 6

The blade (Fig. 5) is rigidly welded to a soft iron armature and a suspension spring. This assembly is suspended between two field magnetic poles (one north, the other south). Depending on current direction, a small north or south pole is generated in the armature when the control winding is energized. This pole produces a force which moves the armature/blade assembly clockwise or counterclockwise around the torsional pivot. The motion is proportional to the current level. Also, with current removed, the spring returns the armature/blade to center—a definite safety feature. In addition, the low power required permits the pilot valve to be rated "intrinsically safe".

In summary, (Fig. 6), current regulated at the controller applied to the valve coil alters the magnetic field around the armature. The resultant force, displaces the armature which moves the blade. The blade position regulates the control port pressures at C1 and C2 causing pressure differential which shifts the main valve. This in turn causes motion of the actuator. This motion can be in either direction and is infinitely proportional in each direction.

Bertea - A simple, reliable and dirt tolerant concept waiting to be applied to your most demanding proportional and/or remote control hydraulic requirement

Monoblock and Servo

The Bertea Monoblock proportional valve is a single body unit with self contained straight-thread ports. It is made in two versions-standard and servo. The standard valve is rated at 10 gpm and 3000 psi. Two spool sizes are available, 5 and 10 GPM, each in two styles:

a) cylinder ports blocked
b) cylinder ports open

The pressure port bypasses to tank in center. An optional high pressure carry over is available.

For applications that require closing the loop, Parker Bertea offer the monoblock in a servo version.

The servo valve is identical to the standard with respect to external dimensions. It too is rated up to 10 gpm and 3000 psi and comes in two flow ranges — 0-5 and 0-10 gpm. Only one spool style is used - all ports blocked in center.

These and the sectional valves are described in detail in Bertea catalog 1430.

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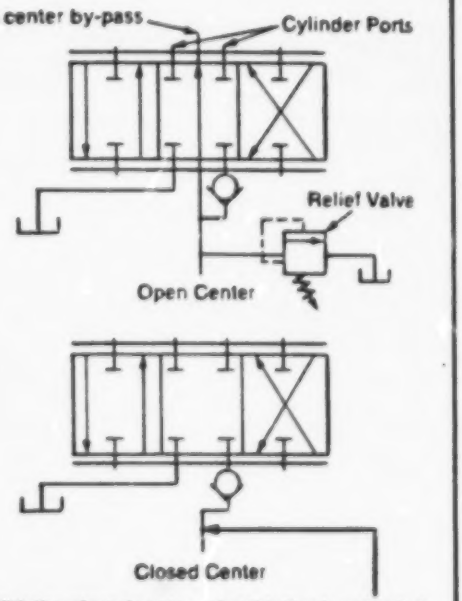
Parker Fluidpower

BASIC OPEN CENTER SYSTEM

Permits operation of up to six functions using a fixed displacement pump. With all spools in neutral, pump flow bypasses to tank. If any spool is actuated the bypass is closed. The portion of fluid selected goes to the actuator and the rest is discharged to tank over the relief valve. To increase system energy efficiency, Bertea offers a By-Pass Compensator and a closed center assembly.

BY-PASS COMPENSATOR
(energy savings using fixed pump)

With all spools in the neutral position, the load sense circuit and the bypass compensator are unloaded which permits the pump to discharge to tank at 25-50 psi. When a spool is actuated, the load pressure is directed through the load sense circuit to the compensator. This load pressure sets the by-pass compensator so that it will dump any excess flow to tank at 100-150 psi above the load requirement. Thus part of the flow goes to the work and part to the tank with the maximum pressure being a fixed amount (about 100-150 psi) above the load pressure.



With the closed center valve this line is unloaded or limited by the pump compensator when used with a variable pump and by the by-pass compensator with fixed pumps.

Figure 7

BASIC CLOSED CENTER SYSTEM
(energy savings using a variable, pressure compensated pump)

With all spools in neutral, the pump goes to maximum pressure set on the pump compensator, but produces no flow to the system. As a spool is selected, the desired flow is delivered at the compensator setting. A drop in pressure occurs across the valve spool equal to the set pump pressure minus the load pressure. The power loss from dumping excess flow over the relief is eliminated. The only heat generation is the result of the required flow and the pressure drop from pump compensator setting to the load level.

VARIABLE PUMP WITH LOAD SENSE VALVE

In the neutral position, the load sense circuit is vented so the pump goes to zero flow at stand-by pressure (150-250 psi). As a spool is actuated, the load sends a signal through the load sense circuit to the pump compensator. It tells the pump what pressure limit is required for the particular job. The pump then provides exactly the desired flow at a pressure about 150-250 psi higher than the load pressure. This additional pressure is to accommodate circuit pressure drop and metering control across the directional control valve spool.

SPOOL COMPENSATORS
(CONSTANT RATE)

In load sensing systems, it often is desired to work more than one function at a time. The load sense circuit is designed to signal the pump the highest load in the system. However, to avoid speed fluctuations in the functions requiring lesser pressure when operated simultaneous with functions needing higher pressure, spool compensators are available on Bertea electro-hydraulic proportional valves.

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Basic Operation

The electrical control of the valve is open loop. The operator provides the feedback to an assembly of

1) An actuator
2) A main valve
3) A pilot valve
4) A d-c controller

The actuator (Fig 1) is connected to the cylinder ports of the main valve. System pressure, P, is introduced as shown. If the main spool moves in either direction, system pressure is connected to one of the cylinder ports. The other cylinder port is connected to return, R, completing the circuit and allowing movement of the cylinder.

Main spool movement is caused by the pressure differential between the control lines C1 and C2. If pressure at C1 is greater than C2 by an amount sufficient to overcome the centering spring, the main spool moves to the right. If C2 is greater than C1, movement is to the left. Not only is this movement reversible but it also can be modulated. With equal pressure at C1 and C2, the high force centering spring moves the spool to neutral, stopping the cylinder - a Bertea feature which has proven to be reliable even in systems too contaminated for other electro-hydraulic valves.

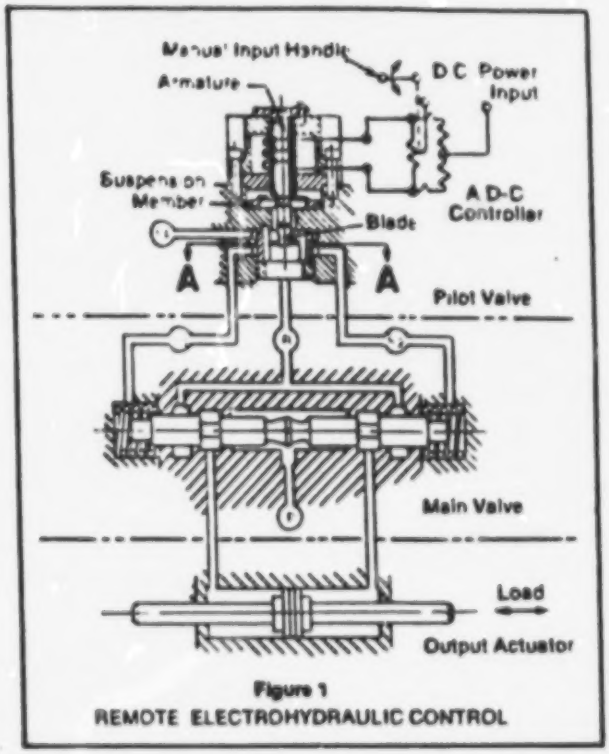

Figure 1
REMOTE ELECTROHYDRAULIC CONTROL

The differential pressure is created in the Bertea pilot valve (Fig. 2). Pilot pressure, Pp, is contained in the "supply" cavity of the diverter plate. This fluid escapes as two jets from the diverter inlet orifices. With the blade centered, pressures in the receiving orifices (C_1 C_2) are equal. The flow passes to the return cavity at low pressure. If the blade moves to the right (Fig. 3), the jet directed at C1 is uninterupted while the jet directed at C2 is blocked. C1 will develop a greater pressure than C2. Fig. 4 shows the reverse, C2 greater than C1.

The smallest orifices in the pilot valve are 500 micron. This provides a very contamination tolerant valve that does not require dither for reliable operation.

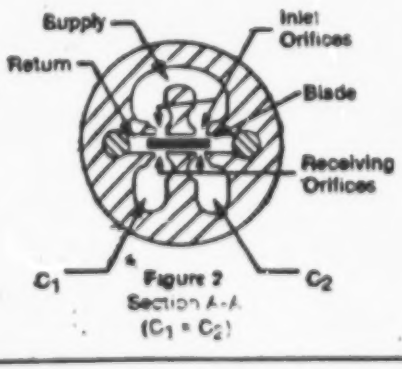

Figure 2
Section A-A
($C_1 = C_2$)

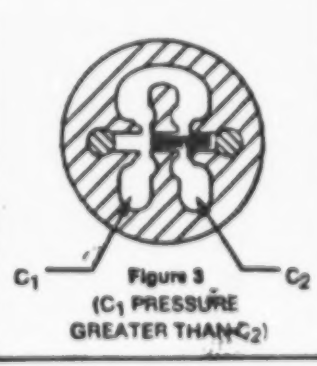

Figure 3
(C_1 PRESSURE GREATER THAN C_2)

Figure 4
(C_2 PRESSURE GREATER THAN C_1)

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Introduction

Bertea valves are four-way proportional directional controls. The Monoblock valve is a single spool valve without load sensing, but available in a full Servo model. The multiple spool valves are sectional valves available in both load sensing and nonload sensing versions. The pilot valve is the same for all units.

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Electrical Controller Data ..... page 12
General Information ..... page 13
Ordering Information ..... pages 14-16

Application Guide

SECTIONAL VALVES NONLOAD SENSING

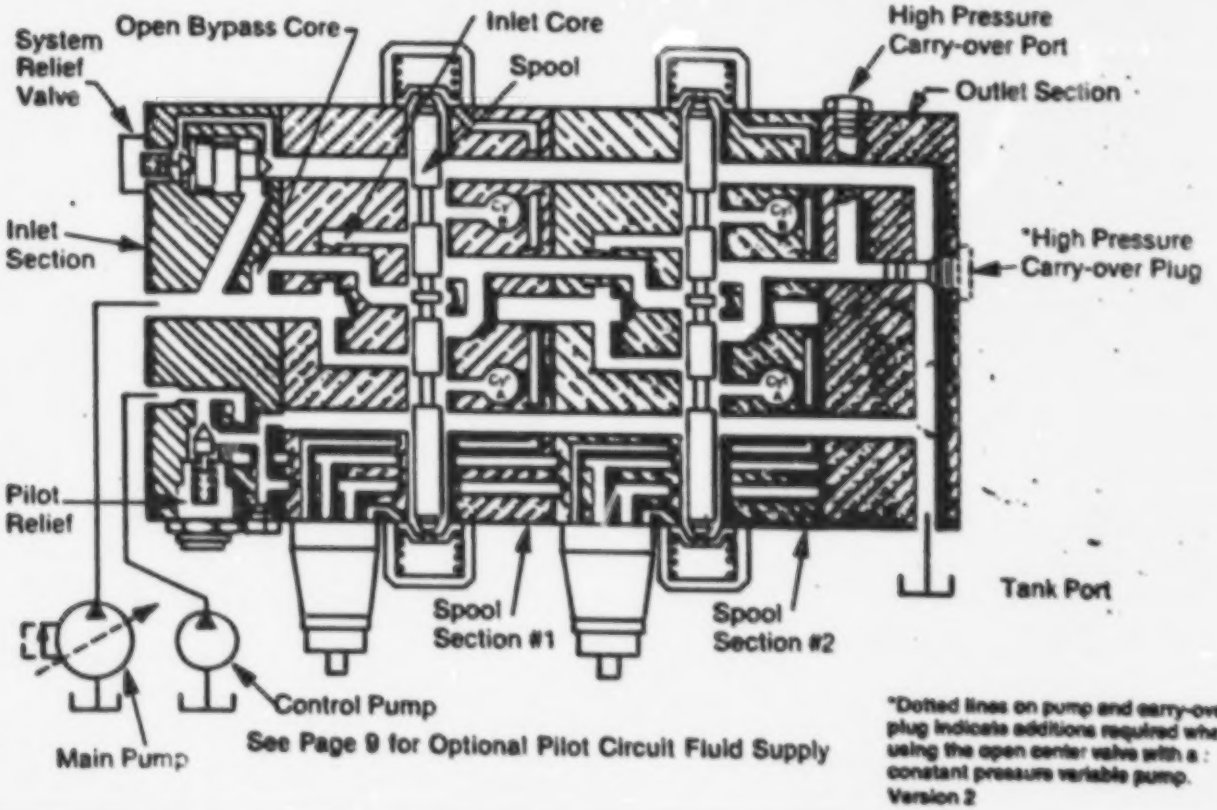
Version 1 (fixed pump; open center, see note*)

With the spools centered, the pump flow will pass to tank at low pressure through the open center. When a spool is fully actuated, the open center is blocked and the inlet is connected to a work port. The other work port is connected to tank completing the circuit. Maximum pressure is controlled by the relief valve. Power beyond to a second valve is available by inserting the carry-over plug.

Version 2 (variable pump; bypass blocked)

The pump sees no flow demand with the spools centered so it strokes to minimum flow maintaining the pressure set on the pump compensator. When a spool is actuated, the pump strokes to provide the exact flow required still maintaining the set pressure (constant pressure system).

In both versions flow can be selected at any spool in either direction in infinitely proportional amounts, up to full pump capacity. Two or more spools can be operated simultaneously. Six spool assemblies have been applied with larger assemblies possible.



See Page 9 for Optional Pilot Circuit Fluid Supply

*Dotted lines on pump and carry-over plug indicate additions required when using the open center valve with a constant pressure variable pump. Version 2

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The load pressure can also be used to control the compensator on a variable pressure compensated pump. As on the previous page, the load signal comes from the sensing circuit. The logic core in combination with the logic checks select the highest load requirement as the signal to the pump compensator. The pump then reacts to two possible conditions:

(1) (all spools centered) No load signal is present so the pump goes to minimum flow at 150-250 PSI which is the value of the compensator spring.

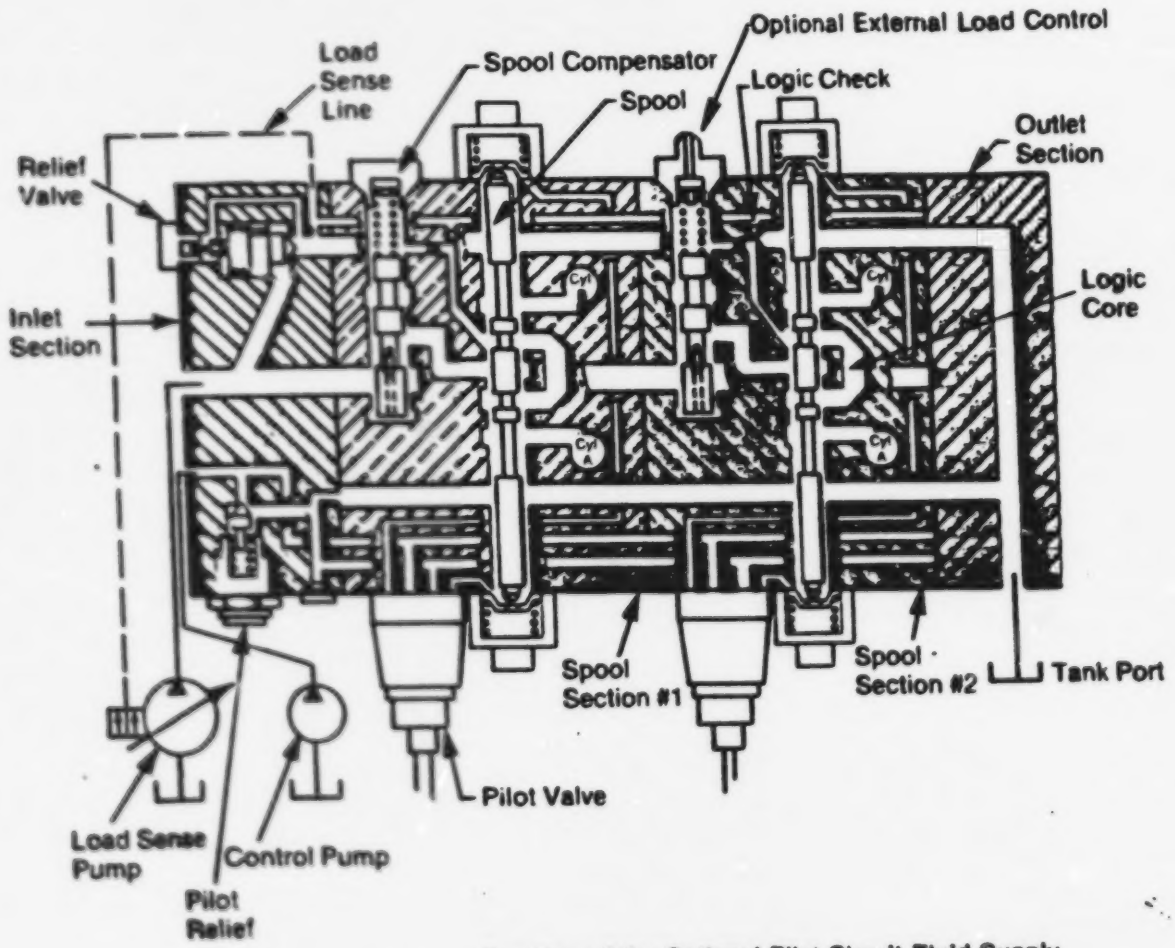
(2) (spool actuated) The highest load signals the pump to build to load pressure plus the 150-250 PSI requirement of the spring.

Thus under any load condition, the pump provides the flow demand at a pressure equal to 150-250 PSI above the load. This 150-250 PSI will vary with each manufacturer's pump. A system pressure limit is provided by the integral relief in the Bertea inlet section.

In multiple operation, speed fluctuation due to different pressure requirements are minimized by the spool compensators which are standard on the Bertea load sensing work modules.

In addition to full four way proportional operation, the Bertea sectional valves are available with these options:

(1) cylinder port reliefs
(2) anti-cavitation checks
(3) manual override end caps
(4) solenoid dump for integral relief



See Page 9 for Optional Pilot Circuit Fluid Supply

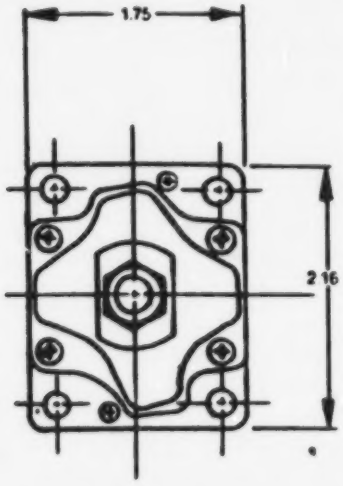
APPLICATION REQUIREMENTS

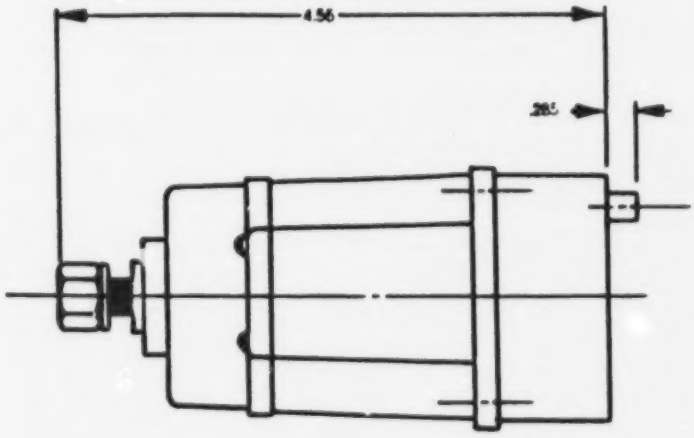
Maximum Supply Pressure ..... 500 PSI
Maximum Return Pressure ..... 100 PSI
Filtration Required ..... 25 micron
Input Flow Required ..... @300 PSID
Standard Model ..... .55 GPM
High Flow Model ..... 1.0 GPM
Coil Resistance ..... 60 ohms
Control Current ..... 60 ma
Control Voltage @ 60 ma ..... 3.6 volts

Intrinsic Safe Approvals
The Bertea pilot valve is approved for Intrinsic Safe operation by both Factory Mutual (Coast Guard regulated applications) and by MSHA for coal mining operations. In all cases, the installation requires an approved power supply to limit the input power to the control circuit.

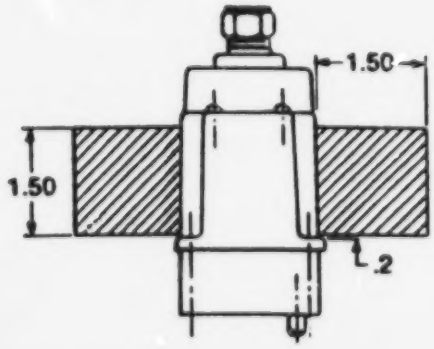
Fluid Selection **Petroleum Base**
Consult Parker for other fluids
Viscosity Range
Minimum (running) ..... 50 SSU
Maximum (start-up)
@ 300 PSID pilot ..... 1800 SSU
@ 400 PSID pilot ..... 2200 SSU
Temperature Range
Maximum (running) ..... 225° F
Minimum (start-up) start-up temperature cannot cause viscosity to exceed above limits

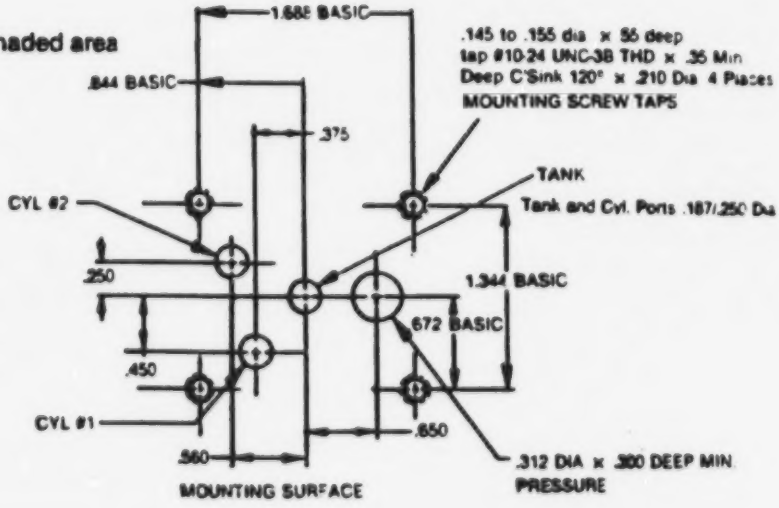
Factory Mutual Approval
Class I, Division I, Groups C & D
Class II, Division I, Groups F & G
Class III, Division I





NOTE: No magnetic material allowed in shaded area as shown.





Rated Pressure 3000 PSI

Max. Tank Line Pressure

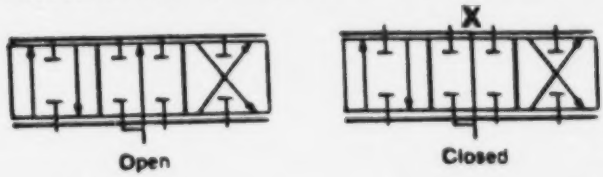
Pilot Return Condition	Tank PSI Limit
External	500PSI
Internal*	100PSI

*Due to 100 PSI limit on pilot valve return

Valve Styles

Nonload Sensing--is an open center four way using bypasses to unload the pump in center. By adding a plug and opening the carry-over port, power beyond is available to a second valve. The main valve has first priority.

A closed center, nonload sensing valve can be made by adding the carry-over plug. This would be for use with variable pumps in a constant pressure system.



Load Sensing—is a closed center valve with load sense logic and spool compensators. One version also has a bypass compensator for use with fixed pumps. The other version is for variable pressure compensated pumps.

Note: All spools have load drop checks.

Options

Cylinder Port Reliefs with 25 GPM rating

Anti-cavitation Checks can be ordered per pair of cylinder ports with 10 GPM rating

Manual Override End Caps are available instead of standard adjustable caps.

Mid Inlet

For both load sense & non-load sense circuits

Flow Capacities

Parker offers four flow sizes. Adjustable spool stops are standard so exact flow (up to max limit) can be set. Each spool can be ordered with open or closed work ports.

Flow is rated at 150 PSID. For other pressure differentials, the correction curve provides a flow multiplication factor. Of special note is that all LOAD SENSE spools must be applied at 80% of rated flow. Note the 100 PSID flow value for each curve. This is due to the use of a 100 PSI compensator spring on the spool compensator.

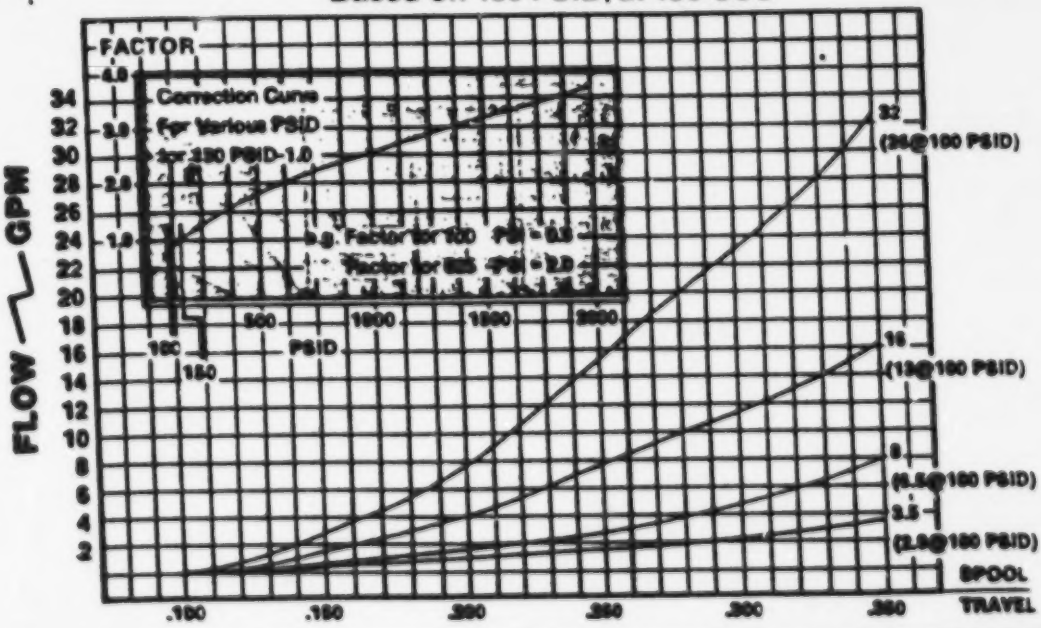
Filtration

System fluid should be maintained an SAE class 5. In addition the pilot circuit should be protected with a 25 micron nominal filter. Consult the Parker Filter Division for selection.

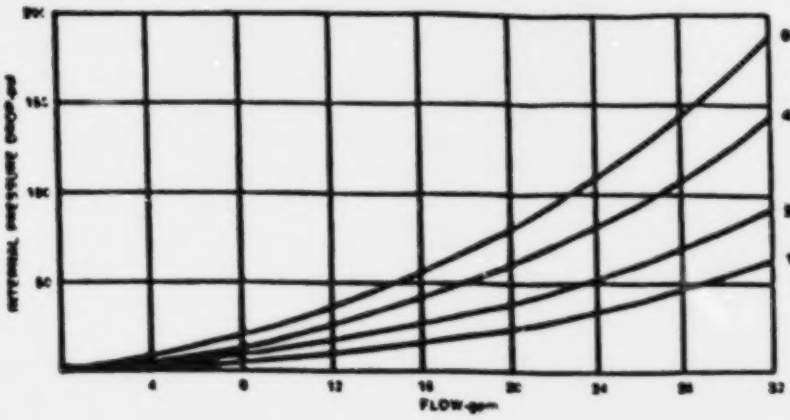
PSID nonload sense—across entire spool section.

PSID load sense—across the notch.

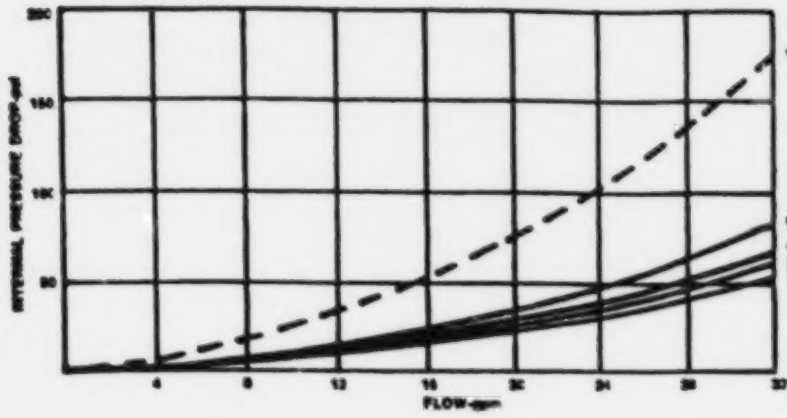
FLOW vs. SPOOL POSITION
Based on 150 PSID, at 100 SSU



Internal pressure drop (Δ P) data are recorded on the following graphs. Values given are the averages of pressure tests made between ports indicated. Oil used in tests was at a temperature (37.7° C) with a viscosity of 100 SSU at 120° F. Curves are for 32 GPM spool only (Non Load Sense).



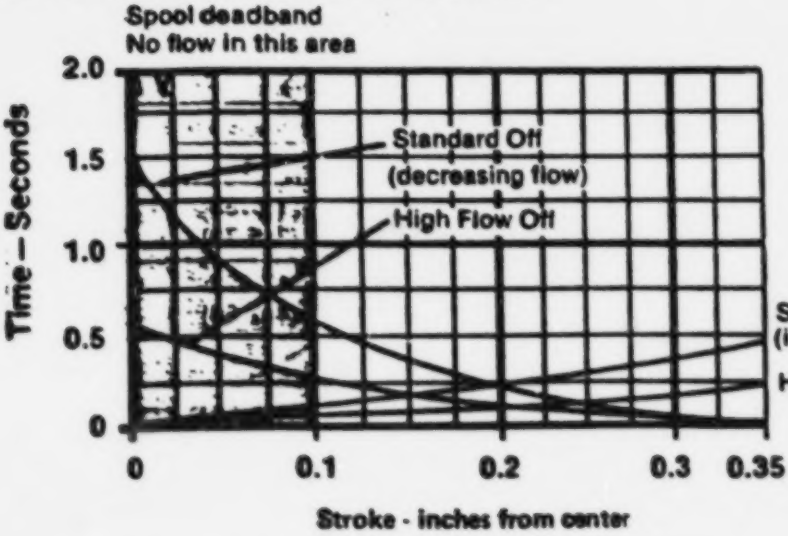
Inlet To Outlet With Open Center



Inlet To Furthest Working Module Cylinder Ports

First Working Module Cylinder Ports To Outlet

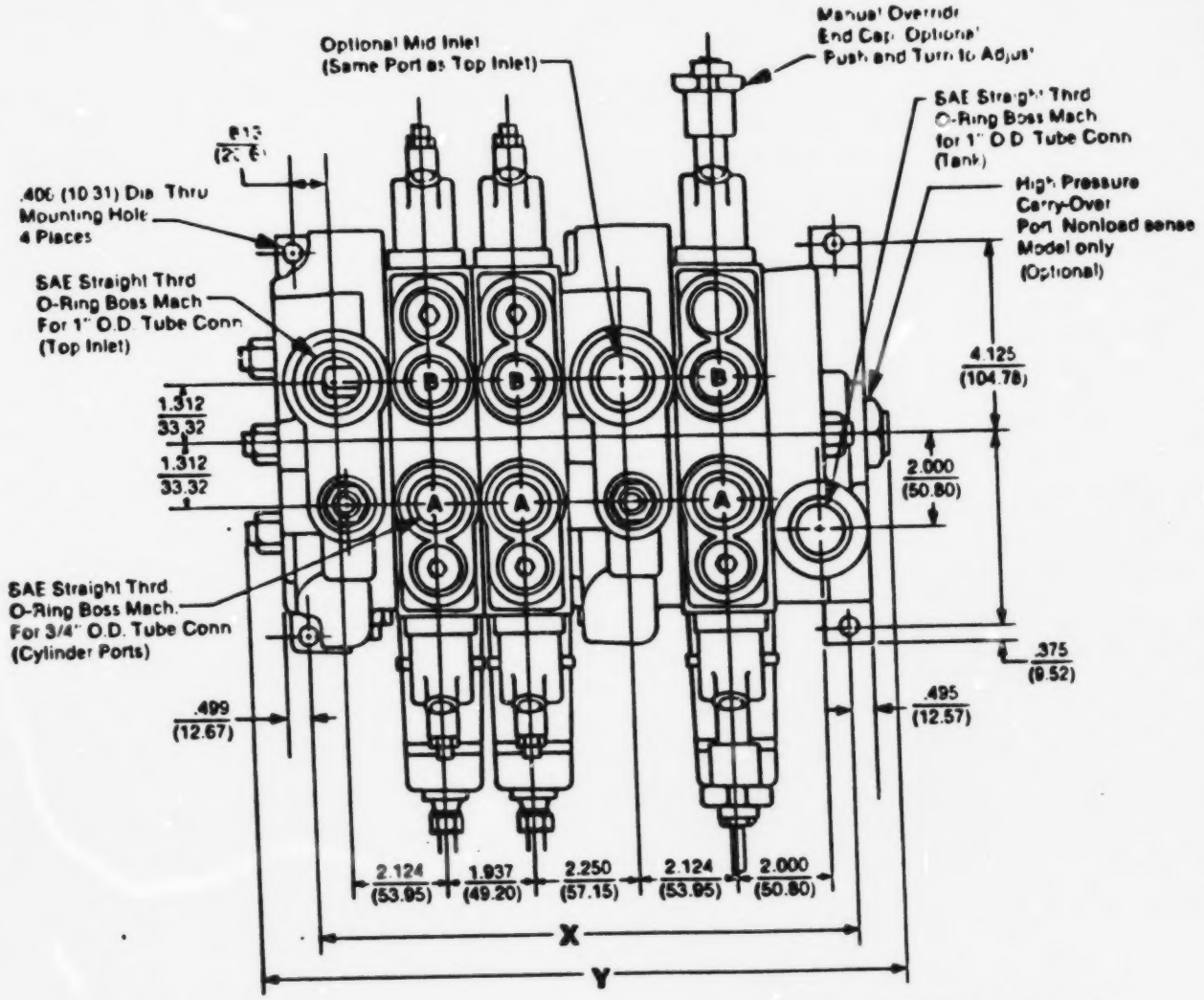
RESPONSE TIME (60 ma step response)



Time On--Start at left (zero stroke) and follow to right as time increases.

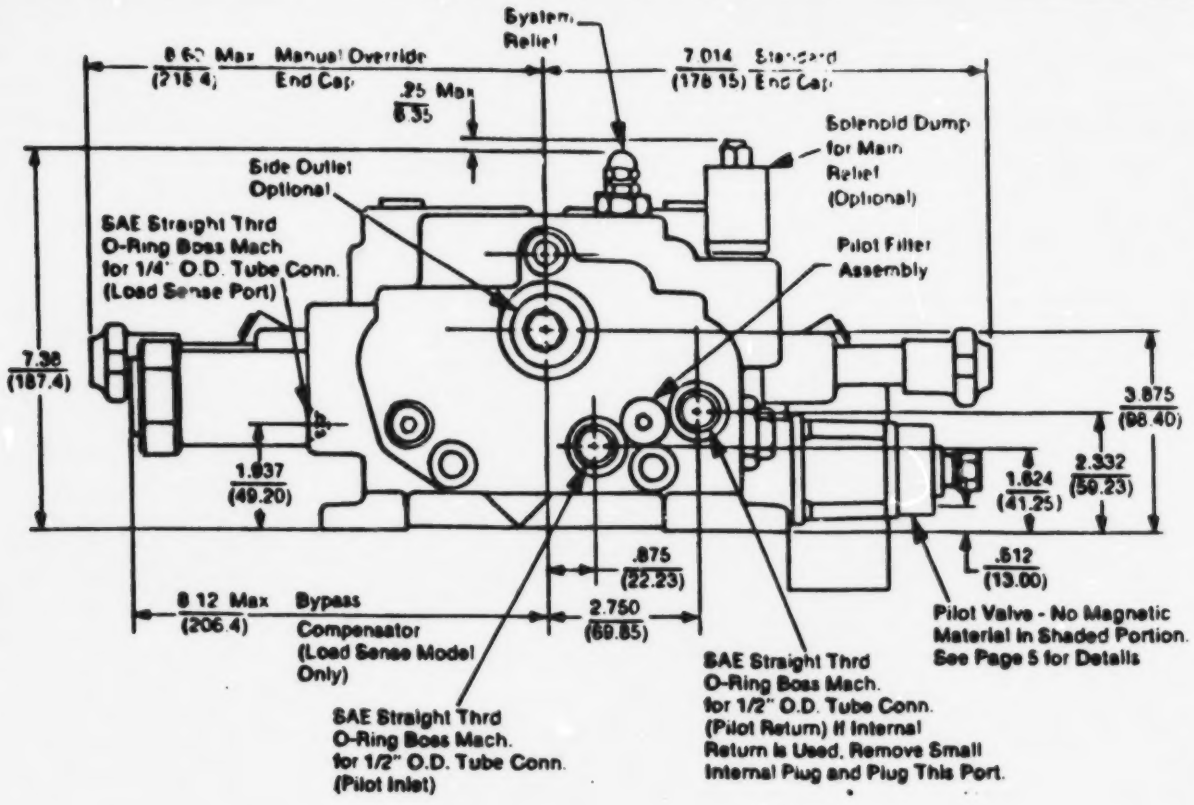
Time Off--Start at right (full stroke) and follow to left as time increases.

Installation Data

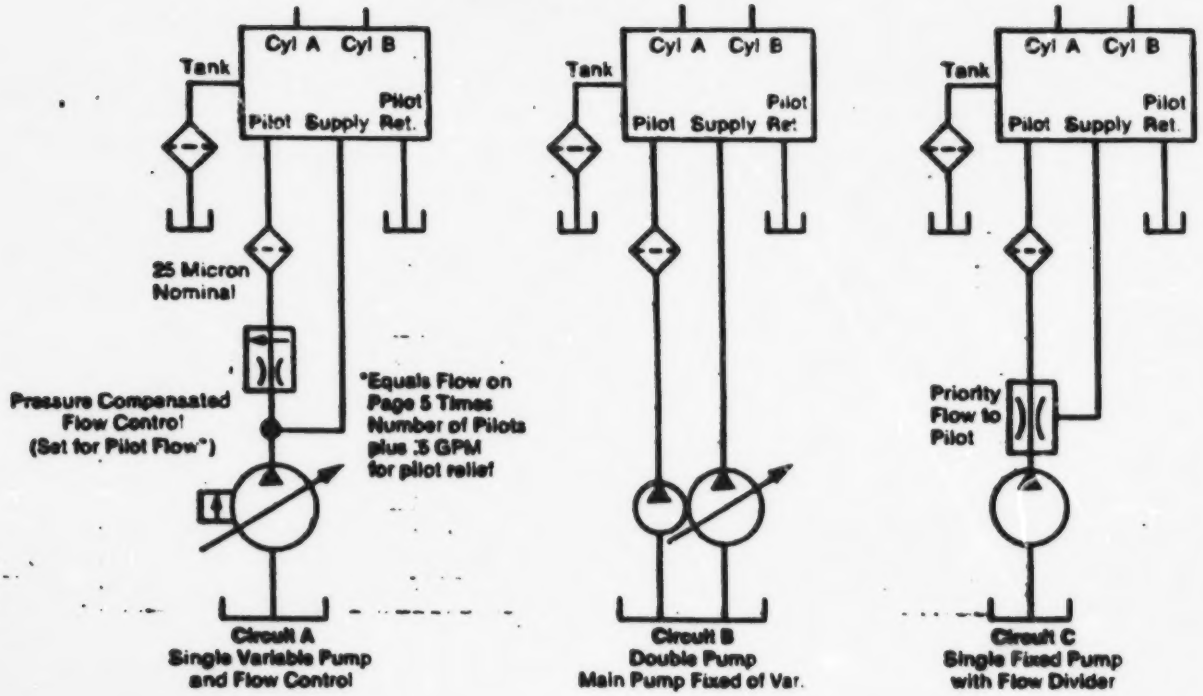


"A" port is closest to pilot valve

	X Dimension						Y Dimension
	Number of Working Sections						Add
	1	2	3	4	5	6	To X
Without Mid-Inlet	5.500 (139.70)	7.437 (188.90)	9.374 (238.10)	11.311 (287.30)	13.248 (336.50)	15.185 (385.70)	2.32 (58.93)
With Mid-Inlet		9.874 (250.80)	11.811 (300.00)	13.748 (349.20)	15.685 (398.40)	17.622 (447.60)	2.32 (58.93)


System Relief
8.60 Max (218.4) Manual Override End Cap
.25 Max (6.35)
7.014 (178.15) Standard End Cap
Solenoid Dump for Main Relief (Optional)
Side Outlet Optional
SAE Straight Thrd O-Ring Boss Mach for 1/4" O.D. Tube Conn. (Load Sense Port)
Pilot Filter Assembly
7.38 (187.4)
3.875 (98.40)
1.937 (49.20)
1.624 (41.25)
2.332 (59.23)
.875 (22.23)
.812 (13.00)
8.12 Max (206.4) Bypass Compensator (Load Sense Model Only)
2.750 (69.85)
Pilot Valve - No Magnetic Material in Shaded Portion. See Page 5 for Details
SAE Straight Thrd O-Ring Boss Mach. for 1/2" O.D. Tube Conn. (Pilot Return) If Internal Return is Used, Remove Small Internal Plug and Plug This Port.
SAE Straight Thrd O-Ring Boss Mach. for 1/2" O.D. Tube Conn. (Pilot Inlet)

Typical Pilot Circuits



MONOBLOCK

The monoblock family of valves are single spool units that provide various configuration options with the same basic valve body. The difference in these monoblock valves related to spool and return spring configurations. The application requirements will determine the selection. The ordering code numbers are shown on page 16.

The monoblock family uses the same pilot valves as the VS30 Sectional Valves. These pilot valves are separate components that are readily exchanged in the field by the removal of four attachment screws. The basic differences in the monoblock valves are as noted:

VM1 - Standard Valve–This unit provides an optional open center or closed center circuit by the use of a power beyond plug. The spool configuration provides a spring detent at center with a standard spool overlap. Cylinder ports are open or blocked, for use with fixed or variable displacement pumps.

VM2 Servo Valve–The servo is a minimum dead band valve that requires a closed loop electrical control for spool position, for use with variable displacement pumps in closed center systems.

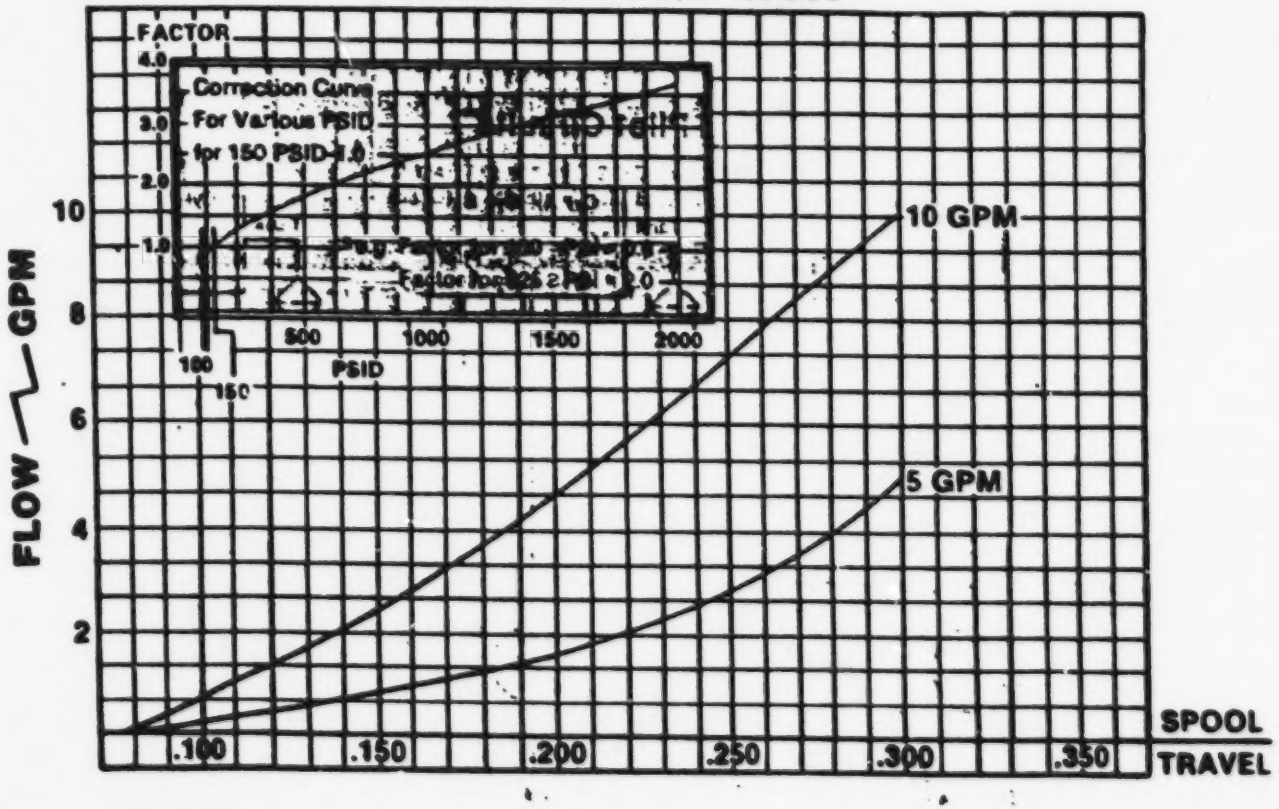
VM3 Low Dead Band Valve–This valve provides a ± 6 ma maximum dead band with a spring detent at center. The spools have a minimum overlap and are open cylinder port only. This valve is for use with variable displacement pumps in closed center circuits.

Power Beyond is available on the Monoblock by adding a plug and piping the bypass port to the second valve.

MONOBLOCK

FLOW vs. SPOOL POSITION

Based on 150 PSID, at 100 SSU



Technical Data

COMMON DATA

Rated Pressure	3000 PSI
Maximum Tank Line Pressure	100 PSI
Filtration	25. micron

Flow Ranges @150 delta PSI
- 0 - 5 GPM
- 0 - 10 GPM

(from min. to max. command)

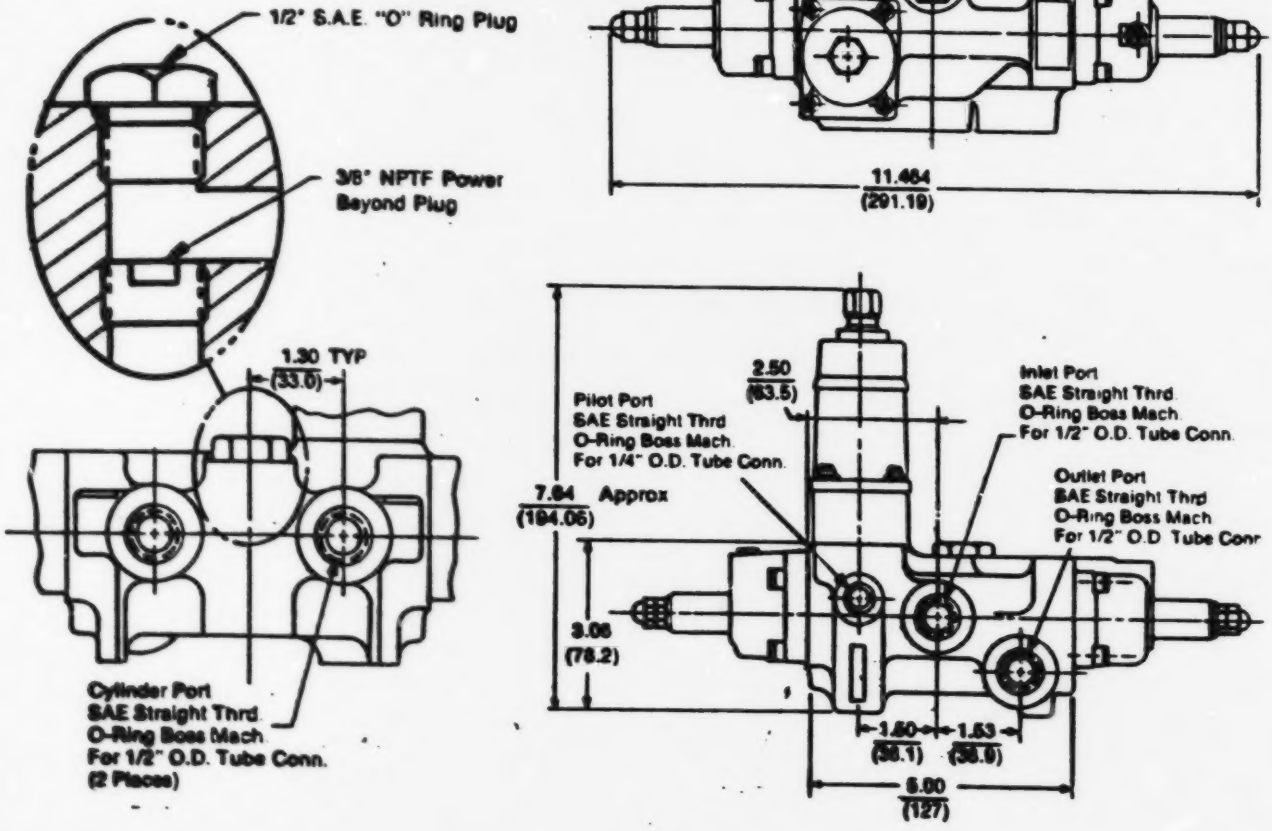
VM1 Standard Valve
- Spring Detent Center
- Dead band ± 12 to 16 ma
- Spool Configurations - open or blocked
- Circuit options - open or closed
- Rated Flow at 150 PSI△ P

VM2 Servo Valve
- Requires Closed Loop Operation
- Threshold - 2 ma
- Response - 0.16 sec. for 63% of step command
- Circuit - Closed Center Rated Flow at 500 PSI△ P
- Send for Bulletin 700100 for additional data
- Servo Amplifiers are available for use with the Bertea Servo Valve.

VM3 Low Dead Band Valve
- Spring Detent Center
- Dead band ± 6 ma
- Spool Configuration - open
- Circuit - Closed Center Rated Flow at 150 PSI△ P.

Installation Dimensions

Monoblock and Servo Dimensions are identical


1/2" S.A.E. "O" Ring Plug
3/8" NPTF Power Beyond Plug
1.30 TYP (33.0)
Cylinder Port SAE Straight Thrd. O-Ring Boss Mach. For 1/2" O.D. Tube Conn. (2 Places)
.406 (10.31) Dia. Thru Mtg. Hole 2 Places
2.09 TYP (5.31)
Power Beyond (HPCO)
11.464 (291.19)
2.50 (63.5)
Pilot Port SAE Straight Thrd O-Ring Boss Mach. For 1/4" O.D. Tube Conn.
Inlet Port SAE Straight Thrd. O-Ring Boss Mach. For 1/2" O.D. Tube Conn.
Outlet Port SAE Straight Thrd O-Ring Boss Mach For 1/2" O.D Tube Conn
7.64 Approx (194.06)
3.00 (76.2)
1.60 (38.1)
1.53 (38.9)
5.00 (127)

Electrical Data

WIRING CONSIDERATIONS

Pilot Valve--Requires two connections to a terminal strip inside the cover. Parker suggests a two strand cable with an O.D. of .200 to .345 (16 to 20 Ga.)

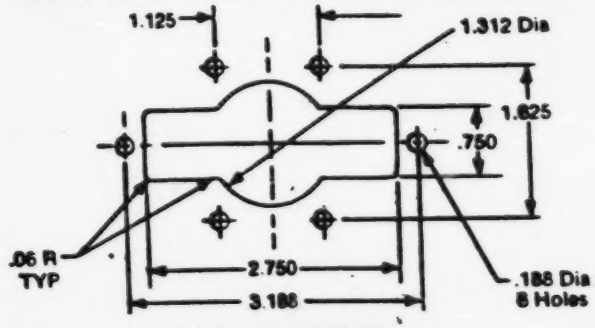
Controller--Described below has a terminal strip requiring five connections:

- two for the valve coil
- two for the power source
- one for the auxiliary function.

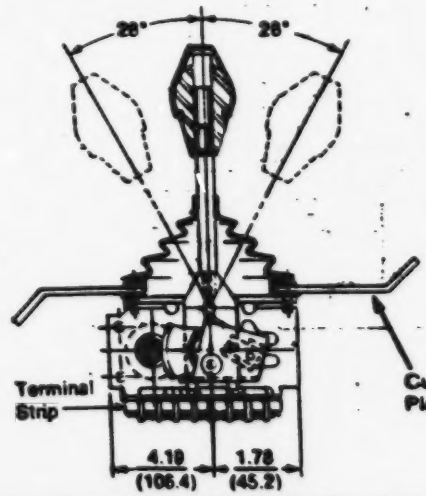
Any cable or combination of cables that meet good industry practice can be used. The following is a guide for use of five lead cable. Use cable with a maximum O.D. of .500 inches and a total resistance not more than 3 ohms.

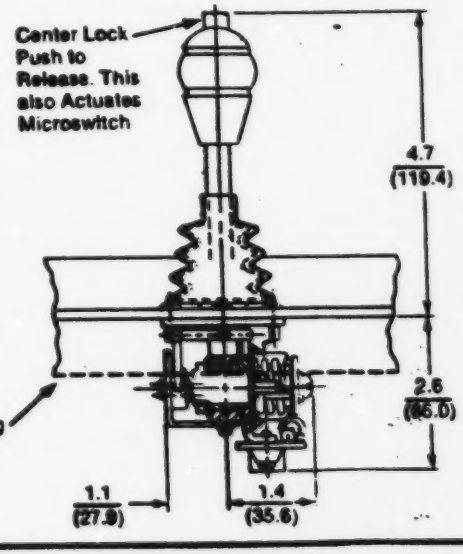
AWG GAGE	R in ohms/1000 ft.
20	10.54
18	6.64
16	4.17
14	2.62
12	1.65
10	1.04

CONTROLLER INSTALLATION DIMENSIONS



Mounting cut-out as shown is required to mount controller





CONTROLLER SPECIFICATIONS

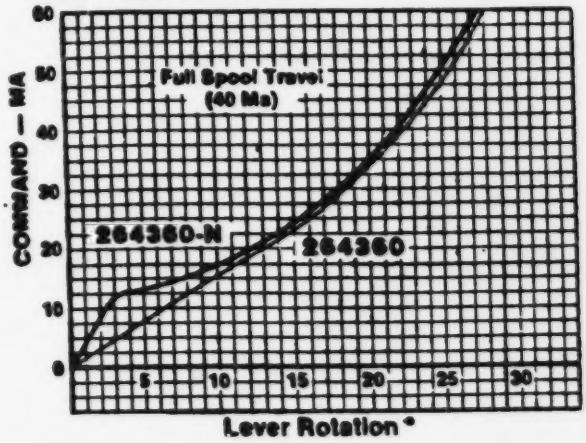
Supply Voltage	12 VDC
Supply Power	0.0 watts @ lever center (microswitch open) 2.8 watts @ max. command position
Output	± 3.6 volts @ 60 ma (with 60 ohm coil)

Microswitch rating 5 amp @ 12 VDC
This switch provides signal for auxiliary functions and maintaining zero power when control is centered

SPECIAL CONTROLS

Both dual control (control of one valve from two locations) and multiple control (control of more than one valve with one controller) are available. Consult your Parker representative for details.

CONTROLLER OUTPUT



Parker Hannifin Corporation
Bertea Industrial Division
Costa Mesa, Calif. 92626
714-879-9770

Parker Fluidpower

Pilot Valve
Electrical Connection: When the red coil wire is positive, the pressure at C^2 is greater than C^1. This increases pressure in the spool end cap opposite to the pilot valve and provides flow from the directional valve cylinder port opposite the pilot valve. A negative signal provides flow from the adjacent cylinder port.

Directional Valve Spool Configuration

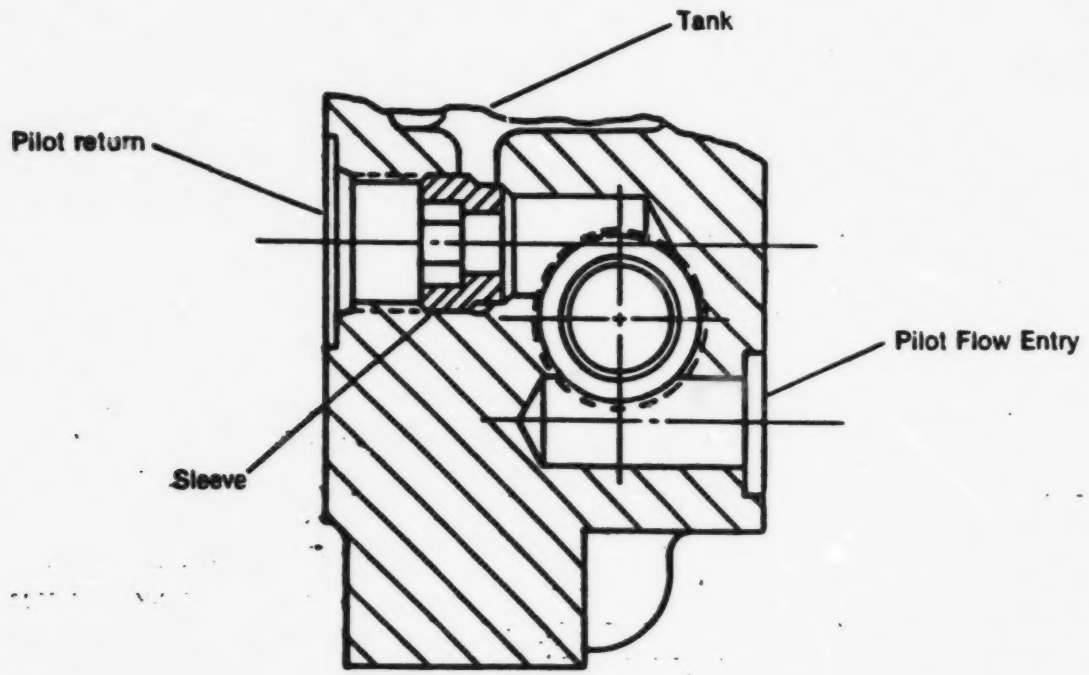
The standard spool configuration is a meter in spool that requires a load holding valve in the cylinder circuit to provide proportional lowering control. Other configurations are available as specials.

Optional Pilot Circuit Drain
The pilot valve fluid circuit is limited to a maximum 500 psi supply pressure and 100 psi return line pressure. The normal configuration is to join the pilot circuit return to the directional valve return, internal to the stack valve.

If it is anticipated that the stack valve return pressure would exceed 100 psi, then a separated pilot circuit return to tank should be used. This requires removing the standard (−6) O-ring plug from the pilot drain port in the face of the inlet manifold and installing the #795288 hollow hex sleeve into the port as shown. The port should then be plumbed to tank separately.

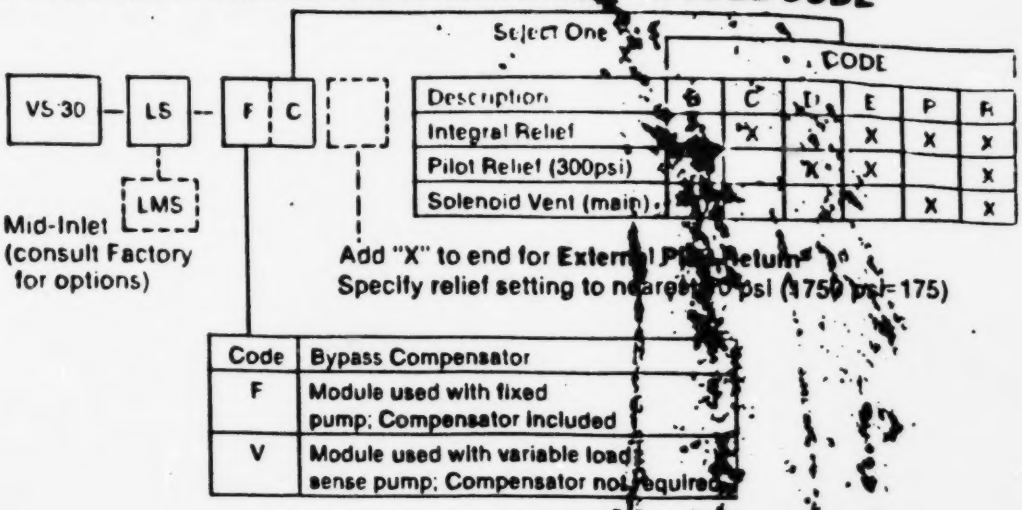
External Load Limiting Control
(Load Sense Version Only)

The maximum pressure in any spool section can be limited to a pressure below maximum pump pressure by connecting the optional external port of the spool compensator spring cavity to an external pressure control circuit. For example a two way solenoid valve plus a relief valve in this circuit provide a section with dual pressure limitation capability.



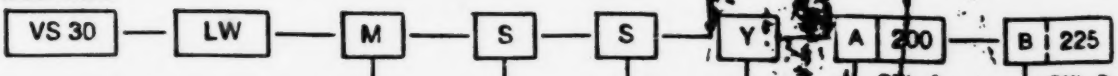
LOAD SENSE STYLE SECTIONAL VALVE ASSEMBLY MODEL CODE

INLET SECTION



Code	Bypass Compensator
F	Module used with fixed pump; Compensator included
V	Module used with variable load sense pump; Compensator not required

WORKING SECTION



Code	GPM	Cylinder Ports
J	2.6	open
K	2.6	blocked
L	6.5	open
M	6.5	blocked
N	13.1	open
P	13.1	blocked
R	26.1	open
S	26.1	blocked

Code	End Cap Style
S	Standard Adjustment
M	Manual Override
L	Lever

Code	Description
Omit	No Port Relief
A	Port Relief (A)
B	Port Relief (B)

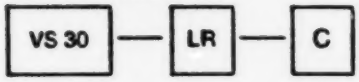
setting number is psi to nearest 10 psi

Code	Anti-Cav Checks
Omit	No Checks
Y	Checks in A and B

Code	Pilot Valve
S	Standard
H	High Flow

See page 6 for flow data

OUTLET SECTION



Assembly Example Order
One 4 (four) spool assembly consisting of:
1) VS 30-LS-PE-250
2) VS 30-LW-L-S-S
3) VS 30-LW-P-S-S
4) VS 30-LW-R-S-S
5) VS 30-LW-R-S-S-Y-A200-B150
6) VS 30-LR-S

Parker Hannifin Corporation
Bertea Industrial Division
Costa Mesa, Calif. 92626
714-979-9770

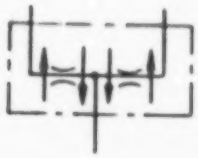
Parker Fluidpower

PRESSURE COMPENSATED
FOR OIL - TO 40 G.P.M. (151 L/MIN)
TO 3000 P.S.I. (210 bar)

USE

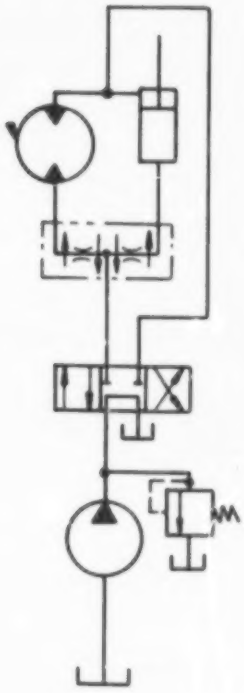
To divide the flow from a pump into equal parts regardless of loads. Normally used to proportion the flow from a single pump into two actuators.

Works as a combiner in the reverse direction.



OPERATION

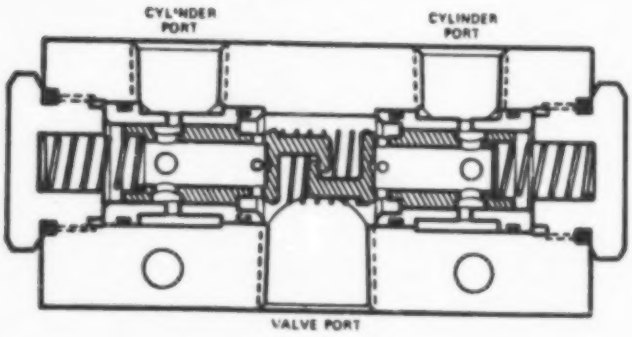
Inlet flow passes thru two matched orifices (one in each spool) to the outlets. If flow to one outlet tends to increase, the greater pressure drop across that spool will cause the spools to shift, restricting that outlet and equalizing the flows. NOTE: Special ratios other than the standard 50/50 are available on request.



FEATURES

One valve synchronizes in two directions.

Dynamically matched honed assemblies give high accuracy even under load imbalance conditions.



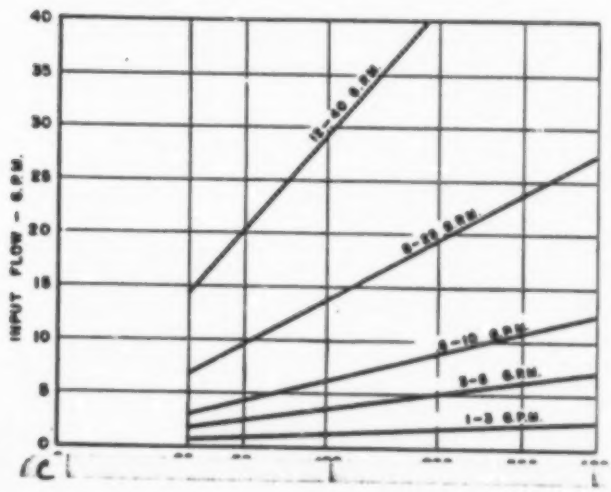
SPECIFICATIONS

MATERIALS: Body, Hi-strength wrought aluminum alloy
Internal parts, hardened steel

RATED FLOW: To 40 G.P.M. (151 L/MIN)

WORKING PRESSURE: To 3000 P.S.I. (210 bar)

RATIO OF DIVISION: 50/50 Standard
Special ratios available on request.

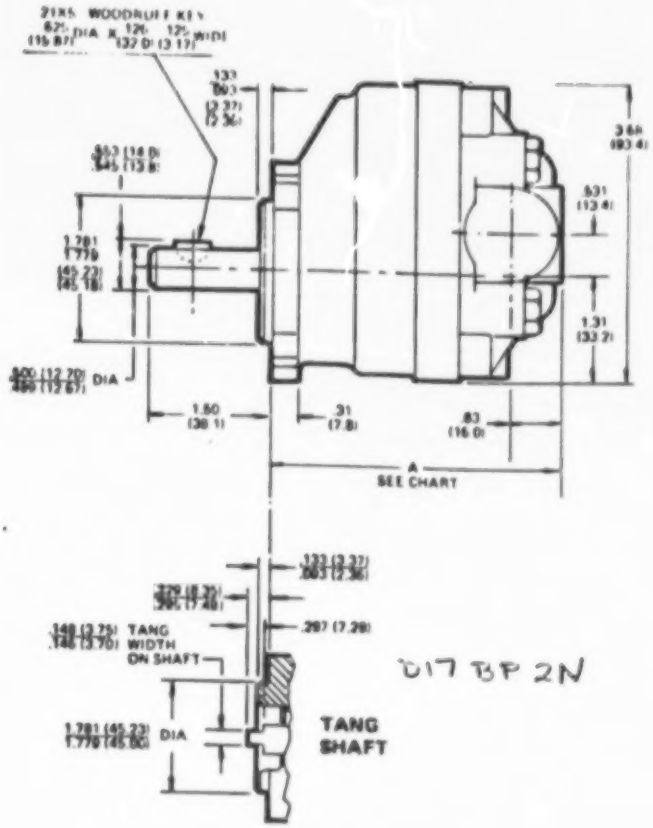


FLOW DIVIDER/COMBINER

DIMENSIONS

INSTALLATION DIMENSIONS - 4 BOLT MOUNTING WITH BUILT IN RELIEF

MILLIMETER EQUIVALENTS FOR INCH
DIMENSIONS ARE SHOWN IN (**)

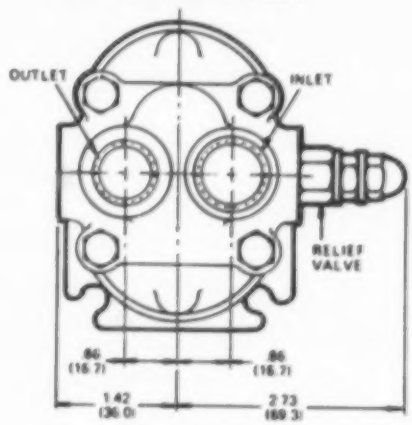


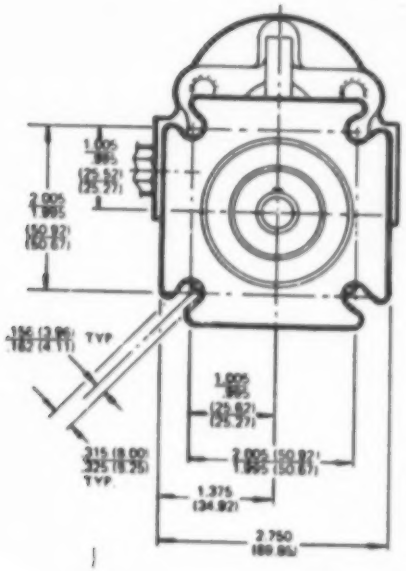
D17 BP 2N

"A" DIMENSIONS

D05	D07	D09	D11
3.22 (81.7)	3.31 (84.0)	3.38 (85.8)	3.47 (88.1)
D14	D17	D22	D27
3.58 (90.9)	3.70 (93.9)	3.90 (99.0)	4.09 (103.8)

BUILT IN RELIEF VALVE



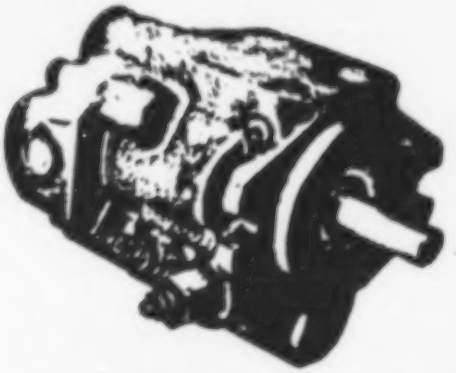


NOTE: Relief valve vents from outlet to inlet. This pump should be applied for intermittant duty only. Consult factory for temperature rise vs time.

Parker Hannifin Corporation
Mobile Hydraulic Division
17325 Euclid Avenue
Cleveland, Ohio 44112

HYDRAULIC PUMP (SECONDARY)

ENGINEERING PERFORMANCE DATA



SPEED
Minimum 600 RPM
Maximum 3000 RPM

PRESSURE
3000 PSI (207 Bar) Continuous

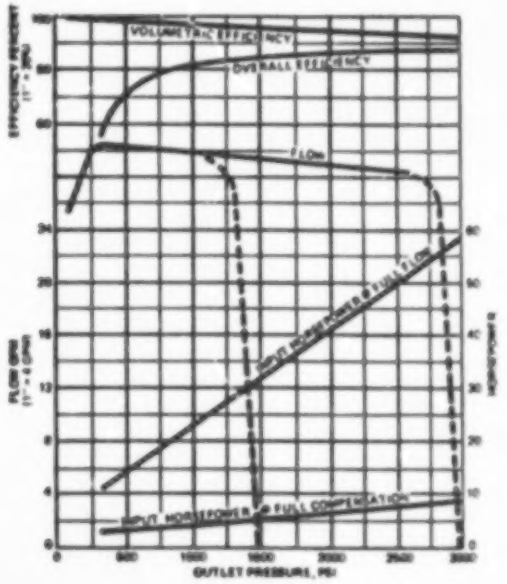
QUICK REFERENCE DATA CHART

PUMP MODEL	DISPLACEMENT IN^3 (CC)/REV.	PUMP DELIVERY @ 300 PSI IN GPM (LPM)		*APPROX. NOISE LEVELS db(A) @ FULL FLOW 1800 RPM (1200 RPM)				HORSEPOWER AT 1800 RPM AND AT MAX. PRESSURE & DISPLACEMENT	MAXIMUM FLOW GPM (LPM)
		1200 RPM	1800 RPM	500 PSI	1000 PSI	2000 PSI	3000 PSI		
PAVC-65	4.0 (65)	20.8 (78.7)	31.2 (118.1)	77 (75)	78 (76)	80 (78)	81 (79)	56.5	50 (188)

*Noise levels are A-weighted, mean sound pressure levels at 1 metre from the pump, measured and recorded in accordance with applicable ISO and NFPA standards. Since many variables such as mounting, tank style, plant layout, etc., affect noise levels, it cannot be assumed that the above readings will be equal to those in the field. The above values are for guidance in selecting the proper pump.

BASED ON OIL TEMPERATURE OF 120°F. (100 SSU)
1800 RPM – ATMOSPHERIC INLET

PAVC-65



NOTE:
The efficiencies and data in the above graph are good only for pumps running 1800 RPM and stroked to maximum. To calculate approximate horsepower for other conditions, use the following formula.

$$HP = \left[\frac{Q \times (PSI)}{1714}\right] \times (CHp) \times \frac{N}{1800}$$

Actual GPM is directly proportional to drive speed and maximum volume setting. Flow loss, however, is a function of pressure only.

WHERE:

- **Q =** Actual Output Flow In GPM
- **PSI =** Pressure At Pump Outlet
- **CHp =** Input Horsepower @ Full Compensation @ 1800 RPM (from Graph above read at operating pressure)
- **N =** Drive Speed In RPM

Industrial Hydraulic Division
100 Parker Drive, Otsego, MI 49078

HYDRAULIC PUMP (MAIN)

Char-Lynn 6000 Series Low Speed-High Torque Hydraulic Motor

Higher Pressure Ratings—Higher Torque Ratings

The new improved Char-Lynn® 6000 Series hydraulic motor will accept pressures up to 3,200 PSI continuously and 4,500 PSI peak. These pressures produce even higher torque than previous models—up to 9,800 pound inches continuously and 11,900 pound inches peak.

The small package gives you the capability of designing equipment for overall compactness. Smaller reservoirs, pumps and lines can be used. You can make full use of the high pressure ratings typical of other present day system components.

Geroler displacement mechanism

This is the "heart" of Char-Lynn low speed, high torque hydraulic motors. It provides smooth operation and long life. It can eliminate, in many cases, the need for gear reduction devices such as gears, shafts, chains, sprockets, belts, pulleys, etc. Provides unlimited rotation. Direction of rotation can be changed instantly with equal torque in either direction.

High Efficiencies

The 6000 Series motors provide high efficiencies. That means more torque is delivered to the output shaft. Less input power is required. Because of the high volumetric efficiency, speed is relatively constant with little variation due to changes in load.

Speed is controlled easily and smoothly over a wide range. It also means less heat in the system. The high mechanical efficiency enables you to obtain a given torque with a smaller motor or at a lower pressure.

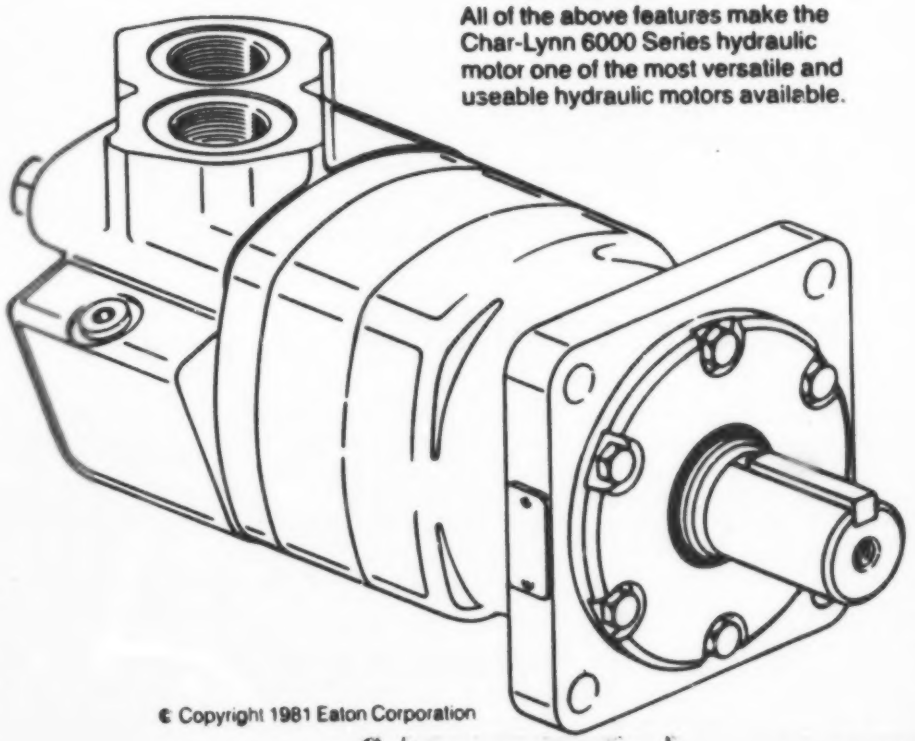
High Radial Load Capacity

Because of design changes to the output shaft, radial load capacity has been increased. The tapered roller bearings supporting the output shaft permit radial loads up to 11,000 pounds. In many cases this eliminates the need for bearing blocks or other outboard bearings. Provides simplicity and freedom in design by eliminating or reducing the number of mechanical components such as gears, shafts, chains, sprockets, belts, pulleys, etc.

Wide Variety of Options

- Six displacements—five new displacements—up to 60 cu. in./rev. Provides greater variety than previous models.
- Three shaft configurations—now designed to fit more applications. Longer straight keyed and splined output shafts.
- Three mounting styles to fit many types of applications.
- Standard ports—changed to $1^{5}/_{16}$"-12 straight thread o-ring connection makes the motor adaptable to more applications.
- New internal drive shaft—spline tooth design changed to provide more strength and long life.
- Case drain location—easy connection for external case drain when required.

All of the above features make the Char-Lynn 6000 Series hydraulic motor one of the most versatile and useable hydraulic motors available.



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SLEW HYDRAULIC MOTOR

☐ Cap ☐ Palm

☐ Mech. interlock ☐ Round

AXIS A-B — AXIS C-D

☒ SPRING RETURN ☒

☐ FRICTION HELD ☐

☐ ☐ ☐

STANDARD SWITCHING GATES

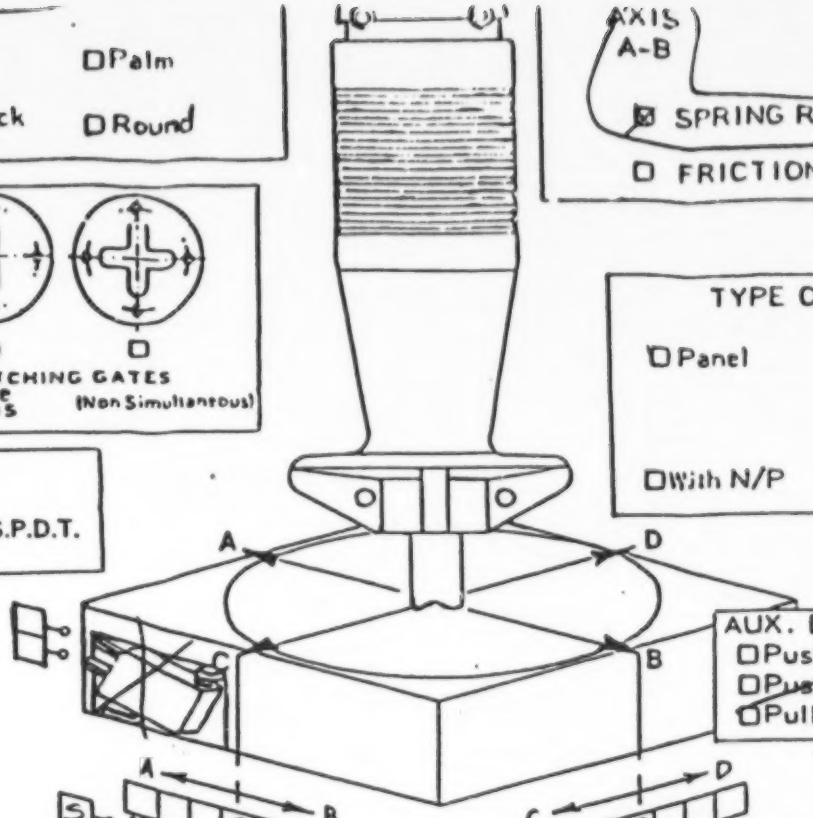
(Simultaneous) one AXIS (Non Simultaneous)

TYPE OF MOUNTING

☐ Panel ☒ Other FLANGE

☐ With N/P ☒ Without N/P

Contacts are
V3 microswitches S.P.D.T.

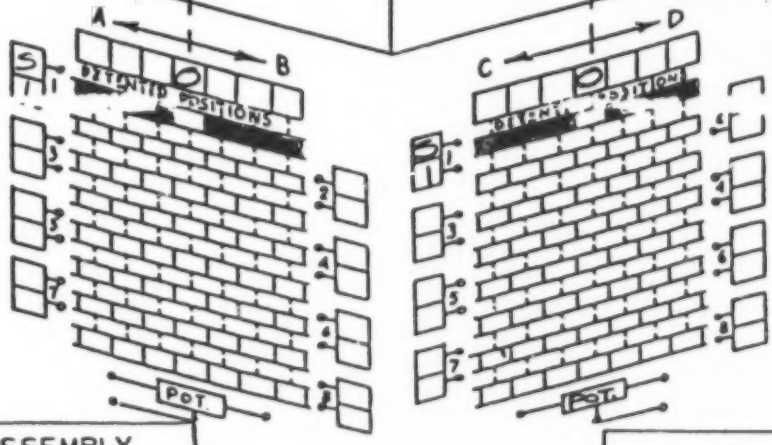


AUX. DEADMAN-CONTACT

☐ Push button in handle.

☐ Push handle down.

☐ Pull handle up.



WITH THUMB SWITCH

POTENTIOMETER ASSEMBLY

AXIS A-B w/ ELECTRONIC IAC / 7496E AXIS C-D

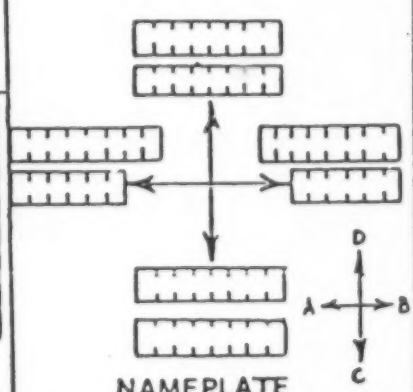
☒ POT. W/ TERM. BD. ☐

Pot. Rotation ☒ 285° ☐ Other

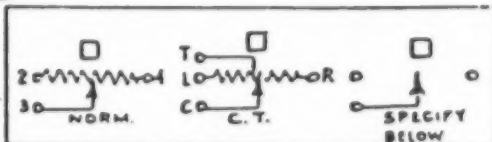
POT. SPECIFICATIONS		
	A-B AXIS	C-D AXIS
MFG.	CLAROSTAT	CLAROSTAT
TYPE	EP 296	EP 296
MODEL		
RES.	200 Ω	200 Ω
WATT	2W	2W
UFC		

☒ OEM mtd. ☒ OEM supplied

☐ Cust. mtd. ☐ Cust. supplied



NAMEPLATE



NOTES: 1. O'REST W/HEAVY DUTY SPRINGS.
2. IAC PER 7496E BOARDS
3. POT PLATE MODIFIED PER 2915AM
4. P.C.B. PER 2891AM ANTI-ROTATION.

OEM controls, inc.
10 Controls Drive Shelton, Conn. 06484
Phone (203) 929-8431

CUST: TELEDYNE

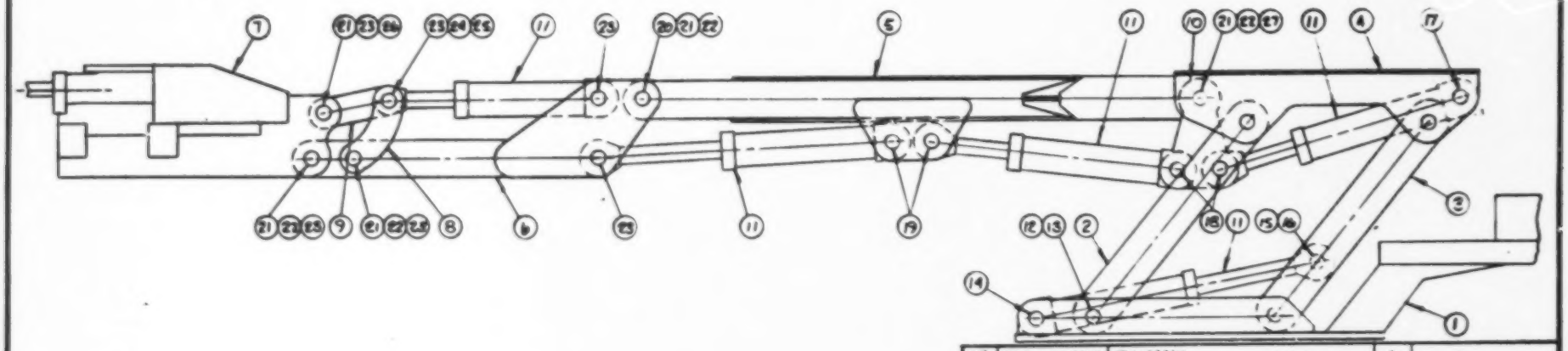
P/N: EJSIM 39EE (C)

DATE 10/21/74 REV.

DRAWN FR

DUAL AXIS JOYSTICK CONTROLLERS

210-8312-C



27	700-0053A	PIN ASS'Y	1
26	730-0020-A	SPACER	1
25	730-0026A	THRUST WASHER	2
24	710-0005A	BUSHING	2
23	700-0037A	PIN ASS'Y	6
22	730-0019A	SPACER	4
21	810-0853A	BUSHING	12
20	700-0049A	PIN ASS'Y	1
19	700-0037A	PIN ASS'Y	2
18	700-0039A	PIN ASS'Y	2
17	700-0051A	PIN ASS'Y	1
16	650-1565A	LUG EAR	2
15	700-0032A	PIN ASS'Y	1
14	700-0041A	PIN ASS'Y	1
13	710-0011A	BUSHING	8
12	700-0069A	PIN ASS'Y	8
11	B/S-0581B	HYD CYLINDER	5
10	810-8043-D	(ML) BOOM BASE WELD'T	1
9	210-8033-C	(ML) HAMMER LINK WELD'T	1
8	210-8089-SK	(ML) OUTER LINK WELD'T	1
7	REF.	HAMMER ASS'Y	
6	210-8100-D	(ML) OUTER BOOM ASS'Y	1
5	210-8085-D	(ML) INNER BOOM ASS'Y	1
4	210-8024-D	(ML) PARALLELOGRAM TOP LINK	1
3	210-8078-D	(ML) FORWARD VERTICLE LINK	1
2	210-8080-D	(ML) REAR VERTICLE LINK	1
1	210-8089-C	(ML) TURN TABLE WELD'T	1
ITEM	PART NUMBER	DESCRIPTION	QTY

TELEDYNE CANADA MINING PRODUCTS

DRAWN BY: RWD DATE: JAN 85

CHECKED SCALE: NTS

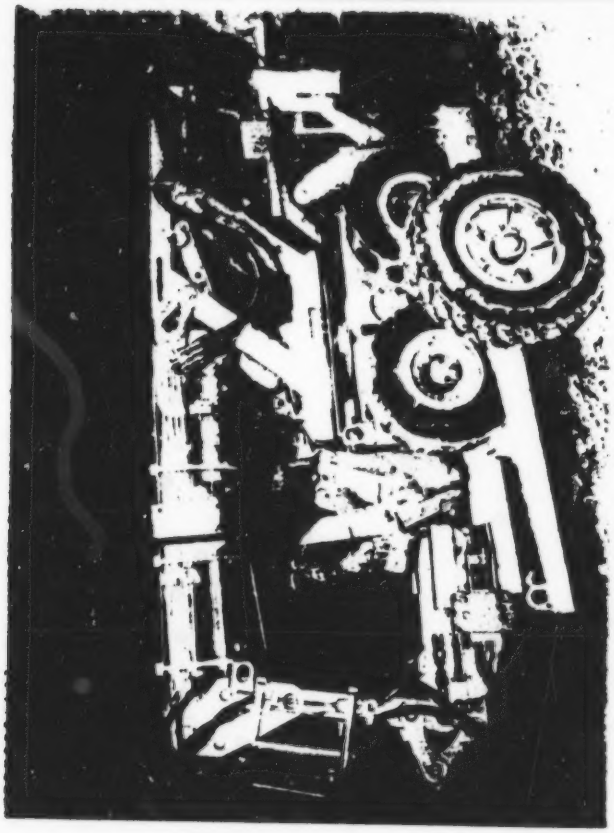
TITLE: BOOM & GENERAL ASSEMBLY

SCALE:

DWG NO. 210-8312-C

APPENDIX "D" 210-8312-C Boom G. A.

APPENDIX "E" Trailer Photograph

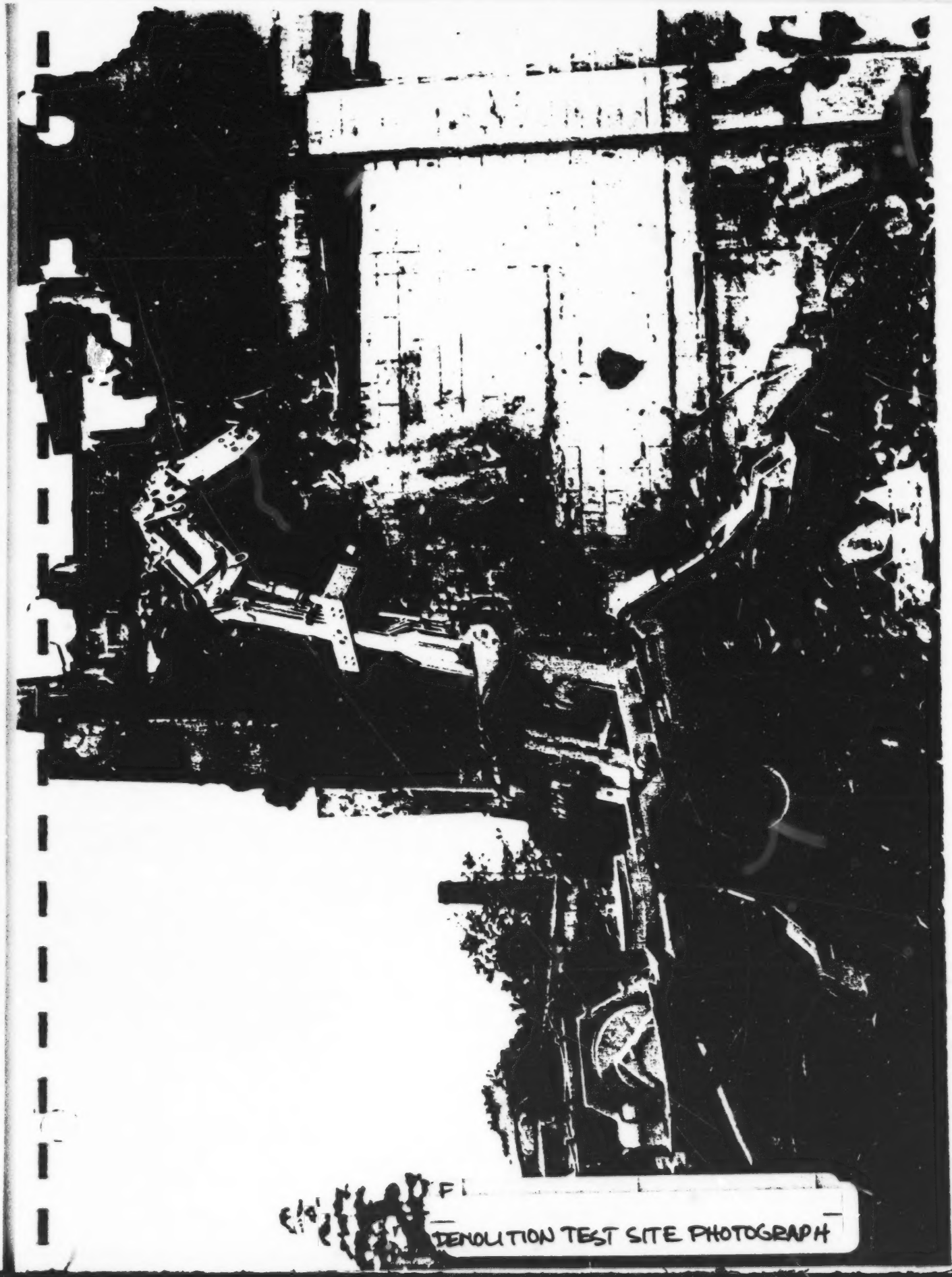


TRAILER PHOTOGRAPH

APPENDIX "F"

Quarry Test Site Photograph
Demolition Test Site Photograph
Underground Test Site Photograph

UNDER GROUND TEST SITE
PHOTOGRAPH



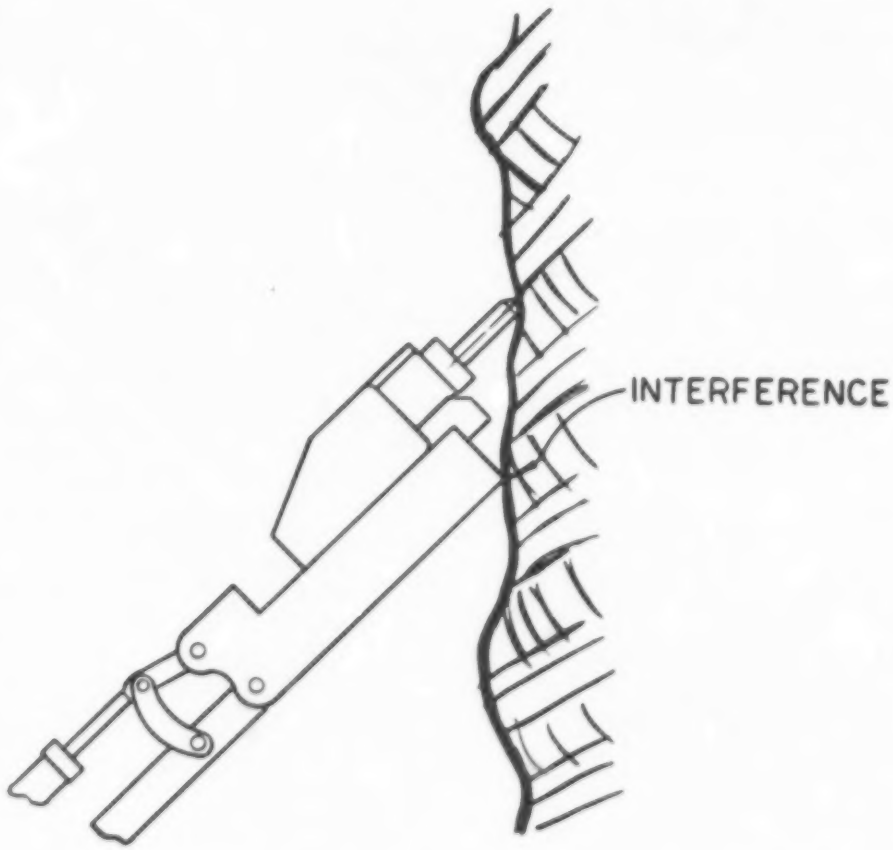
DEMOLITION TEST SITE PHOTOGRAPH

QUARRY TEST SITE PHOTOGRAPH

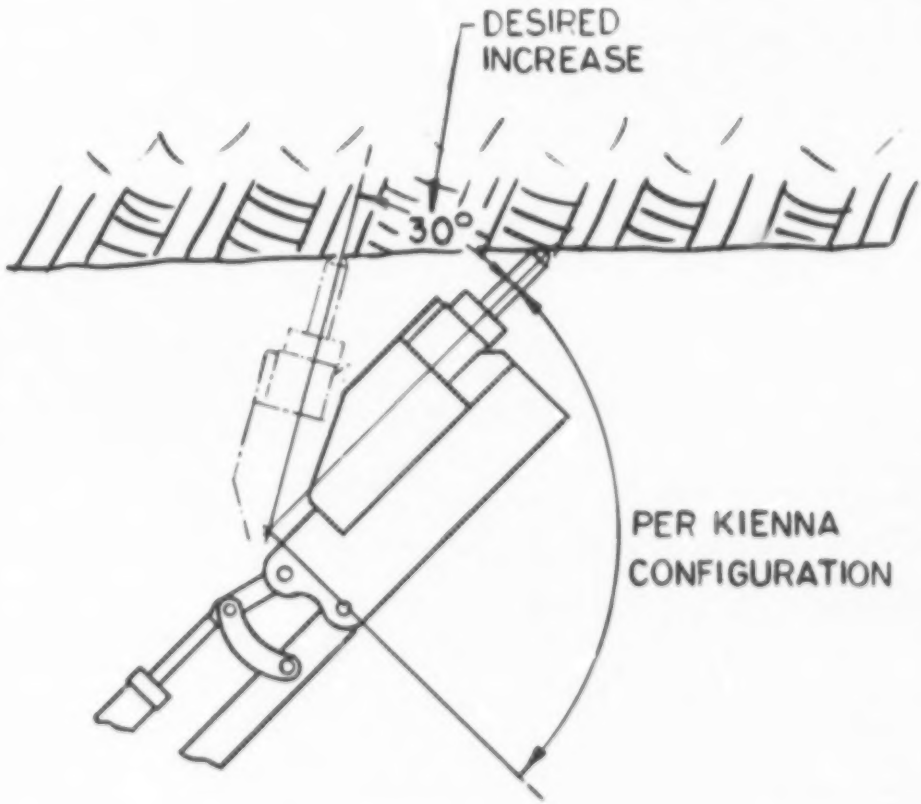
APPENDIX "G"

Breaker Location in Feed Extension

Breaker Tilt Angle



BREAKER LOCATION IN FEED EXTENSION

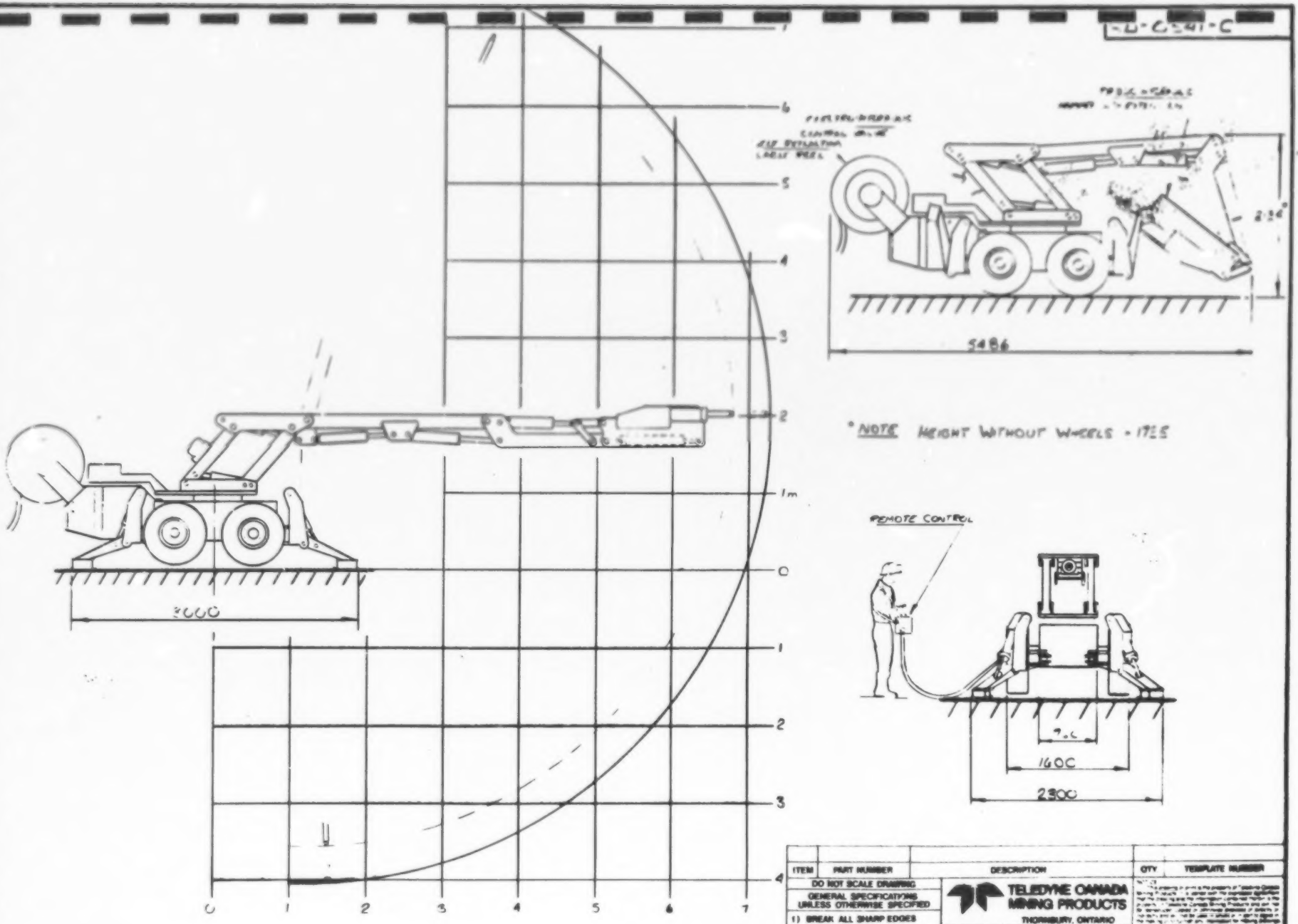


BREAKER TILT ANGLE

APPENDIX "H"

Coverage Drawing
TR200 Breaker Specifications
TR400 Breaker Specifications

SD-0541-C



ITEM	PART NUMBER	DESCRIPTION	QTY	TEMPLATE NUMBER

DO NOT SCALE DRAWING

GENERAL SPECIFICATIONS UNLESS OTHERWISE SPECIFIED

1) BREAK ALL SHARP EDGES
2) TOLERANCE FRACTIONS ± 1/16
.00 ± .03
.000 ± .010
3) ANGLES ± 1°
4) FINISH

TELEDYNE CANADA MINING PRODUCTS
THORNBURY, ONTARIO

DRAWN BY R.W.D. DATE AUG 1984
CHECKED SCALE 1/8 - 1

TITLE
DEMO-DEMON

SIZE A
PART NO SD-0541-C

REV. NO	ECN	BY	DATE	MAT'L

THE TELEDYNE ROXON HYDRAULIC BREAKER SYSTEM

TELEDYNE ROXON 400 HYDRAULIC BREAKER

A multi purpose Hydraulic Breaker of a lightweight design with the impact power of a mid-size Hydraulic Breaker designed to handle a variety of breaking applications for municipalities, utilities and construction.

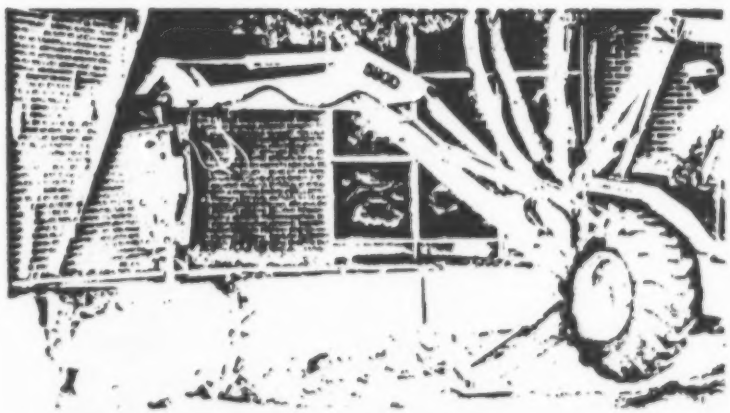
What Can It Do?

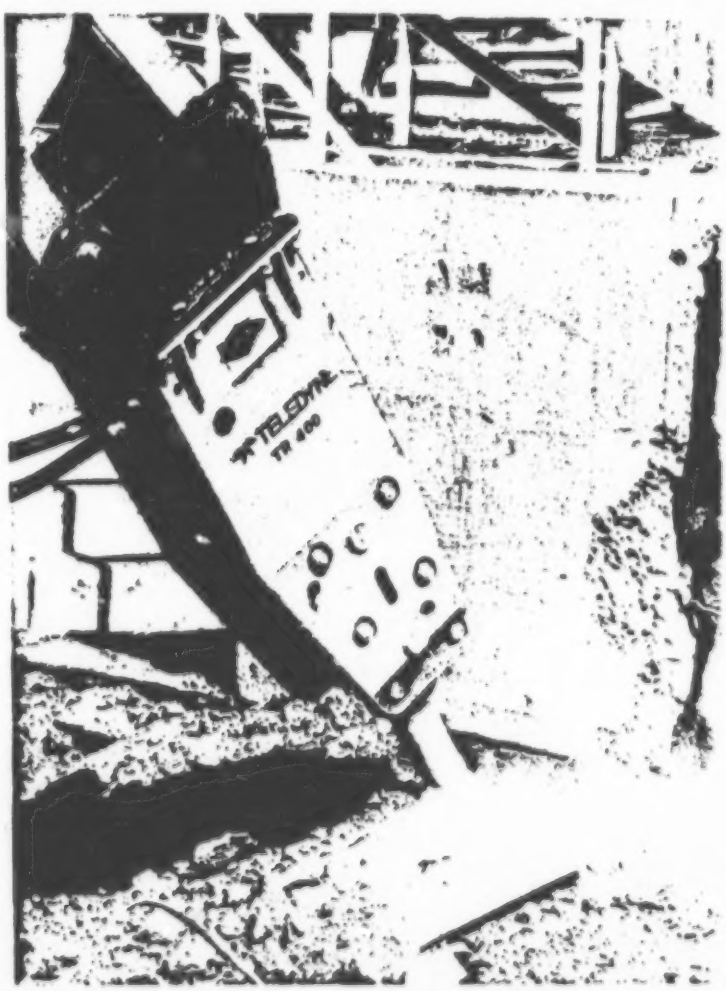
The TR400 Hydraulic Breaker can:

- demolish concrete surfaces and walls
- break frozen ground
- underground mine scaling
- foundry slag
- compaction of loose material
- demolish oversize rock in quarries and mines

What Are Its Applications?

- it is designed for rubber tired back-hoes in the 5-12 ton class and can be mounted to loader buckets in it's class
- to be mounted on an extension feed carriage on a hydraulic boom for scaling, ladle cleanout or kiln brick removal
- stationary hydraulic breaker booms mounted over pan feeders or primary crushers in quarry and mine applications





HYDRAULIC IMPACT POWER

TR 400 BREAKER SPECIFICATION

THE TELEDYNE ROXON HYDRAULIC BREAKER SYSTEM

TELEDYNE ROXON 200 HYDRAULIC BREAKER

A multi purpose Hydraulic Breaker engineered to handle a variety of breaking applications for municipalities, utilities and light construction.

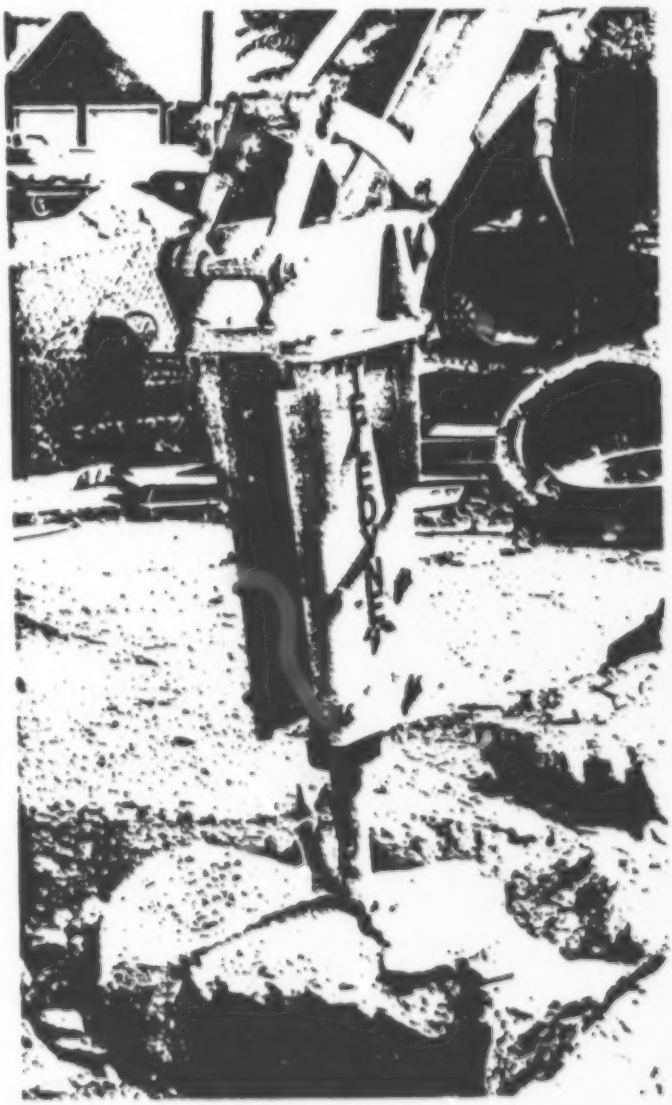
What Can It Do?

The TR200 Hydraulic Breaker can:

- demolish concrete road surfaces or walls
- demolish asphalt
- break or cut frozen ground
- underground mine scaling
- foundry slag
- compaction of loose material

What Are Its Applications?

- it is designed for rubber tired back-hoes in the 4-10 ton class, and can be mounted to loader buckets in it's class
- to be mounted on an extension feed carriage on a hydraulic boom for scaling, ladle cleanout or kiln brick removal



HYDRAULIC BREAKING POWER

TR 200 BREAKER SPECIFICATION

POOR
QUALITY
ORIGINAL